

**FIRST WATT**

**F1 POWER AMPLIFIER**

## Who is First Watt?

That would be me. I've been building audio for about 37 years because that's what I do. While I have a nice business (Pass Labs) to tend in the daytime, sometimes I come home and can't resist making something.

First Watt is a kitchen table operation – the projects that are not appropriate for my day job. I like power amplifiers best, and I have the manufacturer's mentality - never build one when you could make a hundred.

The inspiration for the company name and type of product comes from Dick Olsher ( [www.blackdahlia.com](http://www.blackdahlia.com) ). Dick is a long time hard-core audiophile reviewer whom I respect greatly, and he once said, “The first watt is the most important watt.”

I have more recently heard it expressed as, “Who cares what an amplifier sounds like at 300 watts when it sounds like shit at 1 watt?” (At my kitchen table I can say any word I like as long as it's OK with my wife).

This philosophy dominates First Watt, as does the belief that simple elegant designs are the most worthy of my time and your money. There is a vast range of possibilities that fit that description - I am ferreting out some of the most interesting.

If you have purchased one of these, Thank you and I hope you enjoy it.

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Nelson Pass

[nelson@passlabs.com](mailto:nelson@passlabs.com)

[www.firstwatt.com](http://www.firstwatt.com)

## **Now for Something Completely Different:**

The F1 is a two channel transconductance power amplifier, which is a fancy name for an active current source.

A given input voltage results in a particular output current. Ordinary amplifiers are voltage amplifiers – an input voltage translates into an output voltage. This is not that kind of amplifier, and as of this writing, the F1 is the only such amplifier available for audio use.

Being a current source, the F1 operates differently with a loudspeaker. A regular audio amplifier supplies an arbitrary output voltage, and the speaker draws current according to its complex characteristic. As such, the current through the loudspeaker is not exactly proportional to the voltage in either amplitude or time.

A current source amplifier delivers a precise current to the voice coil of the loudspeaker driver, ignoring the series impedance elements in the circuit, including the wire, the inductance of the voice coil, the resistance of the voice coil versus temperature – all that stuff.

This is potentially valuable in that the current passing through the magnetic field of the loudspeaker produces the force and acceleration on the voice coil and cone, and this translates directly into sound pressure. A current source is simply the most direct way of controlling the acceleration of the voice coil.

Since most loudspeaker systems are designed around a voltage source, there is only a small subset of products that can take good advantage of this effect. In general, these are high-efficiency drivers (ones that produce more than 90 dB per watt). Of greatest interest is the performance offered to high-efficiency full-range drivers, where not only is the loudspeaker very efficient, but also covers (or tries to cover) the full audio spectrum through a single radiating surface.

Often this translates to delicate single cone drivers such as the products from Lowther or Fostex, with big motor assemblies coupled to light fragile paper cones. These are the speakers that often don't sound good with "high quality" solid-state amplifiers, most often because the two are mismatched in impedance and wattage.

This is a very unusual amplifier that will not sound good with about 98% of the loudspeakers on the market. It requires careful attention to loudspeaker loading to get the best performance. The accompanying white paper “Current Source Amplifiers and Full-Range High-Efficiency Drivers” is required reading. This is a tinkerer’s amplifier, and experimental tool. If you just want to be a consumer, then buy something else, otherwise be prepared to patiently experiment with your system to get the best performance.

It does not work well with ordinary passive crossover networks – the components and their locations tend to be reversed. It won’t break, but probably won’t sound good. If you have an electronic crossover, you’re in better shape, at least until I can finish a white paper describing passive crossovers for use with a current source.

If being a current source amplifier isn’t different enough, the F1 is special in other ways. It uses no feedback to reduce distortion, flatten frequency response or create a low output impedance, and it ignores the voltages that appear across the speaker terminals. It also ignores the wire and the quality of your speaker connectors and so on.

The F1 has only one gain stage, not 2 or 3 or 4 or 9. It operates in pure class A mode, which is the very best, but at a cost of constantly drawing 100 watts per channel and only giving 10 watts to the speaker.

It is probably the quietest amplifier you can buy, with a typical figure of about 100 pico-watts noise. A pico-watt is a trillionth of a watt.

As Class A amplifiers go, this one is referred to as a “balanced single-ended Class A” device, in which a single “differential pair” of transistors are biased by three constant current sources.

Like I said, this is an unusual power amplifier. There will be 100 F1’s offered for sale to the public, and then I intend to make a different design.

I mostly built this amplifier myself. I got some help from family and such, but if you find any fingerprints in it, they’re mine. If you have questions, comments or problems, you can reach me via email at

[nelson@passlabs.com](mailto:nelson@passlabs.com)

or [www.firstwatt.com](http://www.firstwatt.com)

## Setup – Read This

Be certain to look at or even read the attached white paper "Current Source Amplifiers and Full-Range High-Efficiency Drivers" in considering how to use this amplifier. It is designed for a particular type of loudspeaker, and may not sound good with others. There is no potential for damage to the amplifier and you are not likely to break the speaker, so go ahead and try any speaker you like - just don't be surprised if it doesn't suit you.

The initial setup of the amplifier is very straight-forward. Place the amplifier in a well-ventilated location, as it draws 200 watts during operation and requires as much opportunity to cool itself as possible. You should be able to put your hands on the heat sink during operation. If you can't do this for 5 seconds or so, they need more ventilation.

On the front panel there are two blue LED lights, one for each channel, indicating power to the channel. On the rear panel you will find pairs of RCA inputs, XLR balanced inputs, speaker outputs, a fuse holder, and AC power receptacle, and on/off switch and a label.

The label will indicate a serial number that is from #0 to #100 and also indicates what AC line voltage the amplifier is set for. If the voltage is 120 VAC, then the fuse value will be a 3AG slow blow fuse rated at 2.5 amps. If the voltage is 240 VAC, then the fuse will be rated at 1.25 amps.

(If the label on the back says "Property of First Watt" then this amplifier was not intended for sale and is not new and carries no warranty.)

You can use either the RCA inputs for single-ended input operation or the balanced XLR input for operation from a source with balanced outputs. If you use the RCA inputs, then be sure to use the included gold plated "U" shorting jumpers between pins 1 and 3 of the XLR connectors as shown here, or the amp won't work properly. Some of you will lose these jumpers, but I can send a replacement. Note that pin 1 of the XLR is ground, and pin 2 is the + input and pin 3 is the - input. Pin 1 of the XLR is exactly the same as RCA ground, and pin 2 is exactly the same as RCA "hot".



The outputs of the amplifier are balanced, and operate at a 13.8 Volt DC potential above ground, just like your car battery. Don't worry, the speaker sees only the difference between them, and not the DC, but don't expect the amplifier to operate properly if you attach either output to ground.

I supply a nice power cord for plugging into the wall, but only for 120 VAC operation. You are welcome to use your own cord assuming it has the appropriate safety approvals and conforms to IEC 320, rated at 15 amps.

The fuse is a 3AG slow blow type, 2.5 amp for 120 VAC and 1.25 amp for 240 VAC. No substitutions. Contact First Watt if you have any questions.

I'm assuming that you know how to attach the speaker cables to the 5 way output connectors provided. I recommend that you make all the connections with the amplifier power switch in the OFF position, but you will not damage the amplifier circuit by accidentally shorting the output or overdriving the input - my concern is more for the safety of any fragile loudspeaker driver you might be using, or maybe even you.

With everything connected up and the source equipment powered up first, you can proceed to turn on the power switch to the amplifier. Turn-on and turn-off thumps and noise are very small in this amplifier, and should not present any hazard to delicate drivers.

At this point you should be able to listen to music. This amplifier has less gain than most, but at 10 watts rating, it doesn't need it. If you need to turn the gain up on your preamp, then do so. If you can't get enough gain, then you are probably using either the wrong speaker or the wrong amplifier. Talk to your dealer if this is the case.

The power supplies of each channel are isolated from each other electrically, except for a thermistor on each which connects the circuit ground to the chassis and earth ground. In this way ground loops are prevented, as the channels will typically share ground only at the source, but the thermistors stand by to conduct AC line voltage to ground until the fuse blows, in case of transformer or other such failure.

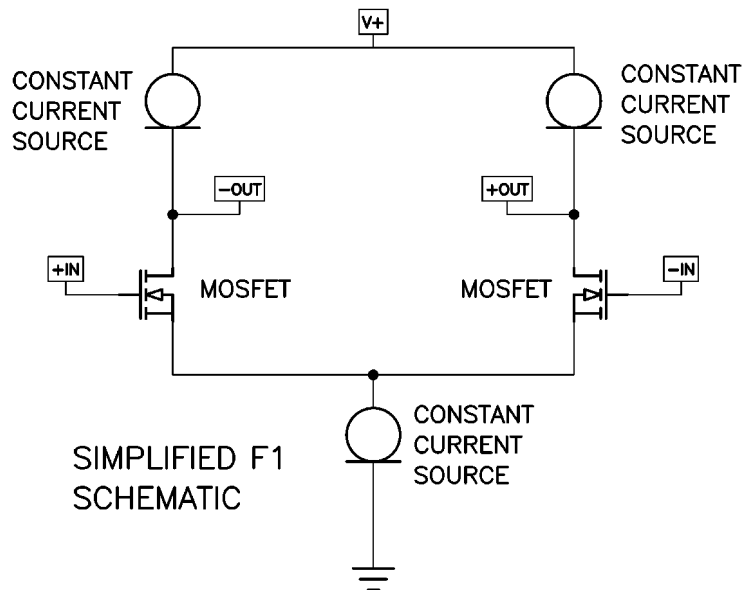
The amplifier requires about 1/2 hour of operation to reach normal operating temperature, and this warm-up time is appropriate for the most critical listening, but is not otherwise an issue, as the performance difference between 5 minutes and 60 minutes is very marginal. I do not personally see a reason to run the amplifier all the time.

While the gain is low, the input impedance of the amplifier is high, about 100 Kohms balanced, depending slightly on the load impedance, so you should find it easy to drive with tube equipment if you like.

One thing that you are likely to notice about the F1 is its phenomenally low output noise, which is typically 100 pico-watts (a pico-watt is a trillionth of a watt) unweighted across the audio band. This is about 1/100 the noise you expect to see from a very high quality audio power amplifier, and is quieter than many preamplifiers.

The performance of the amplifier is nearly identical with either a single-ended input (remember the XLR shorting plug!) or balanced input, except that there are more ultrasonic distortion harmonics with a single-ended input, so you do get slightly better sound from balanced operation.

Here is a simplified schematic of the amplifier:



If you are familiar with the Zen amplifiers published over the past 8 years or so in AudioXpress, then you will see a passing similarity to the Son of Zen, except that the F1 uses constant current sources instead of resistors to power up the gain devices. This increases the efficiency to above 10%, dramatically improves the noise rejection and raises the output impedance from about 16 ohms to about 80 ohms.

Like the Son of Zen, the amplifier does not use feedback for improvement of the audio performance, although there is a DC feedback connection to set the proper DC voltages.

Also like the Son of Zen, the amplifier has a simple third harmonic distortion characteristic, what we expect from a balanced single-ended design.

**Now the following is for your protection, so pay attention:**

Do not defeat the AC line Earth ground connection on the amplifier power cord. It provides an extra barrier to prevent potential shock.

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, 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, turn it off and get a qualified technician to look at it. If you can't touch the heat sinks for 5 seconds or so, consult First Watt or a qualified technician.

There are no user serviceable parts inside. Do not open the amplifier, and if you do, don't operate it with the cover off. There are hazardous voltages inside. If you need to change the operating AC voltage, consult the factory or a qualified technician.

The outputs of the amplifier float at 13.8 volts above chassis ground, but are current limited and at too low a voltage to create shock hazard, but do Not tempt fate by connecting and disconnecting speaker cables and/or input cables with the amplifier turned on.

OK, You've been warned. This is a special experimental and/or developmental product that does not belong in the hands of an ordinary consumer. If you incur damage by ignoring this advice, just remember that you're dealing with Nevada corporations with no assets and no insurance.



## Summary of the nominal specifications:

Input Impedance, balanced	100 Kohms, 8 ohm load
Input Impedance, unbalanced	50 Kohms, 8 ohm load
Output impedance	80 ohms
Output power 8 ohms	10 watts @ 5% THD 1KHz
Output power 4 ohms	6 watts @ 5% THD 1KHz
Output power 16 ohms	9 watts @ 5% THD 1KHz
Gain	14 dB @ 8 ohms
Maximum output voltage	+/- 20 volts
Maximum output current	+/- 1.75 amps
Frequency response	- 3 dB @ 3 Hz, 100 KHz
Noise	30 uV unweighted, 20-20 KHz, 8 ohms
Power consumption	200 watts (100 watts / channel)
Fuse	3AG slow blow , 2.5 Amp for 120 VAC 1.25 Amp for 240 VAC

**Warranty:** Parts and labor for 3 years, not covering shipping or consequential damages. This amplifier is a specialty product. There is no representation that the amplifier will make you happy.

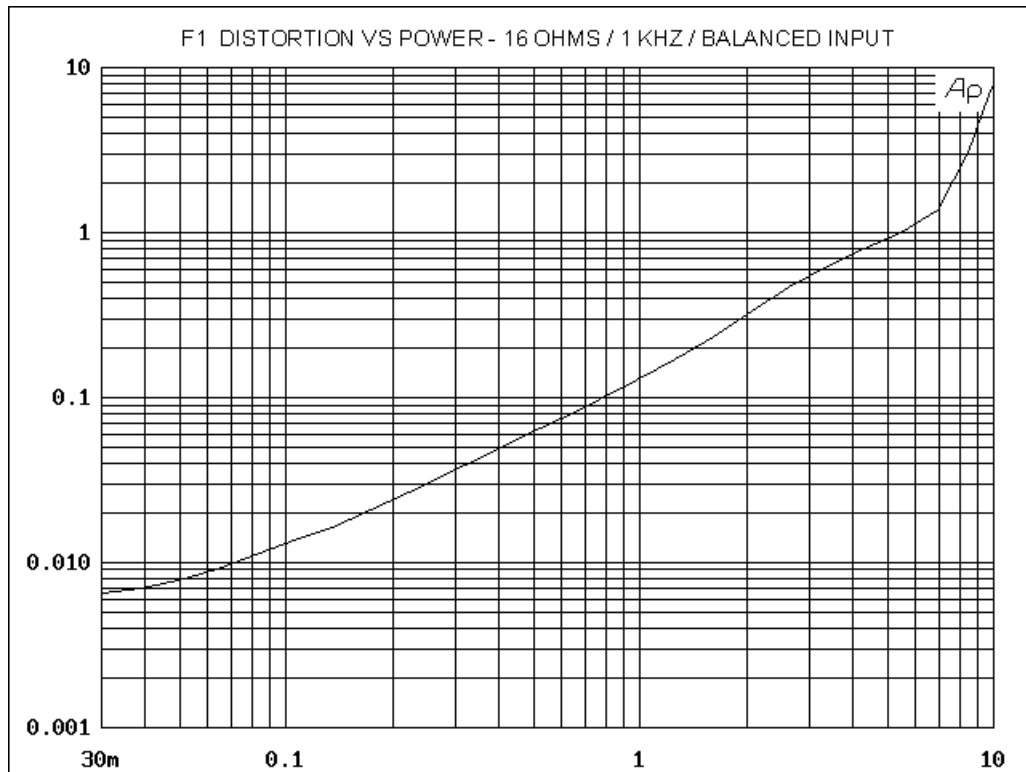
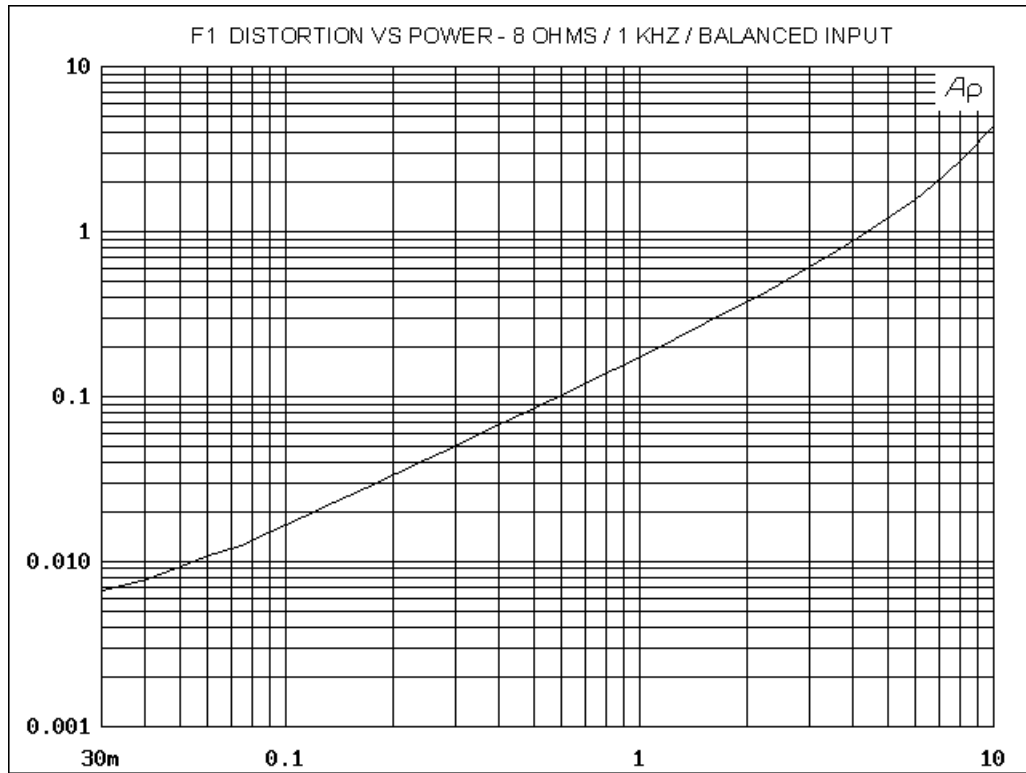
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General Amplifier Inc.  
PO BOX 7607  
RENO NV 89510-7607

[www.Firstwatt.com](http://www.Firstwatt.com)      [nelson@passlabs.com](mailto:nelson@passlabs.com)

## Typical performance curves:



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