

# Power Cord Measurements!

## REVOLUTIONARY ANALYSIS

For years, the debate has raged on-line and off regarding the perceived value of after-market power cords within professional and consumer audio-video systems.

Though there are many sound and visual professionals who report experiencing dramatic differences when replacing stock power cords, there are still skeptics who point to a lack of measurements as proof that no real difference can exist.

*Shunyata Research* scientist, Caelin Gabriel, has put an end to the debate by revealing not only one — but three dramatic measured differences between stock power cords and an inexpensive audio-grade power cord.

The measurements represent three critical performance criteria:

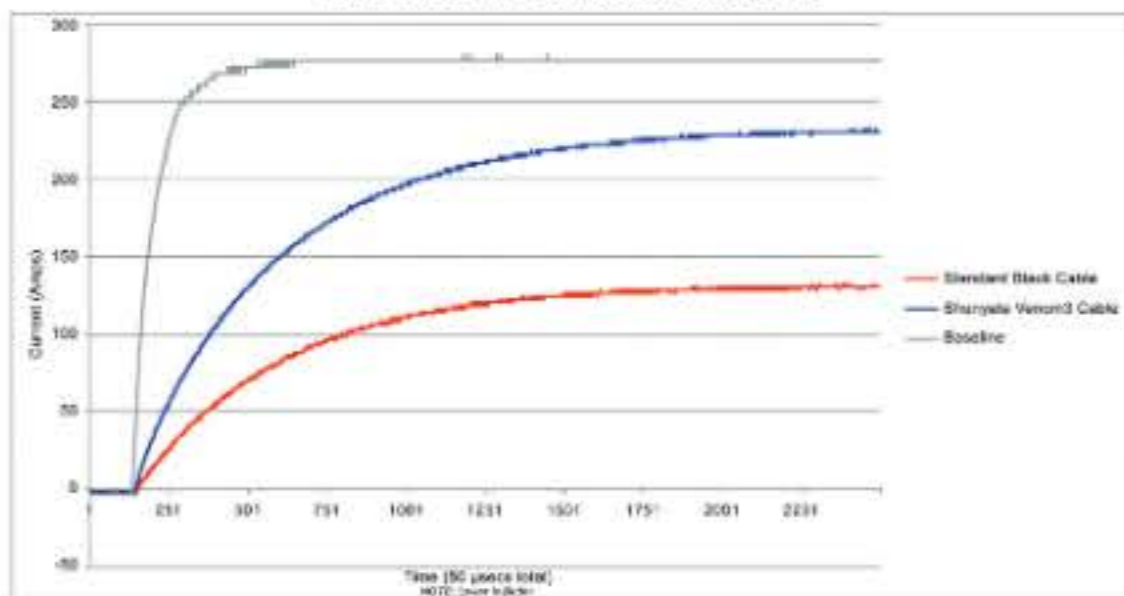
- 1 The quantity of instantaneous current available through a specified power device or circuit. Measured in amperes.
- 2 The amount of voltage drop across the device during the conduction period.
- 3 The stored residual noise component rate of dissipation after the current conduction period (displayed on web-site).

### DTCD (DYNAMIC TRANSIENT CURRENT DELIVERY) ANALYZER

DTCD is a method of current analysis that measures instantaneous current delivery in the context of a pulsed current draw. In layman's terms, it is a way of measuring current performance into typical electronic component power supplies.

The DTCD Analyzer allows the measurement of pulsed transient current through a variety of AC power products, including power cords.

DTCD CURRENT COMPARISONS

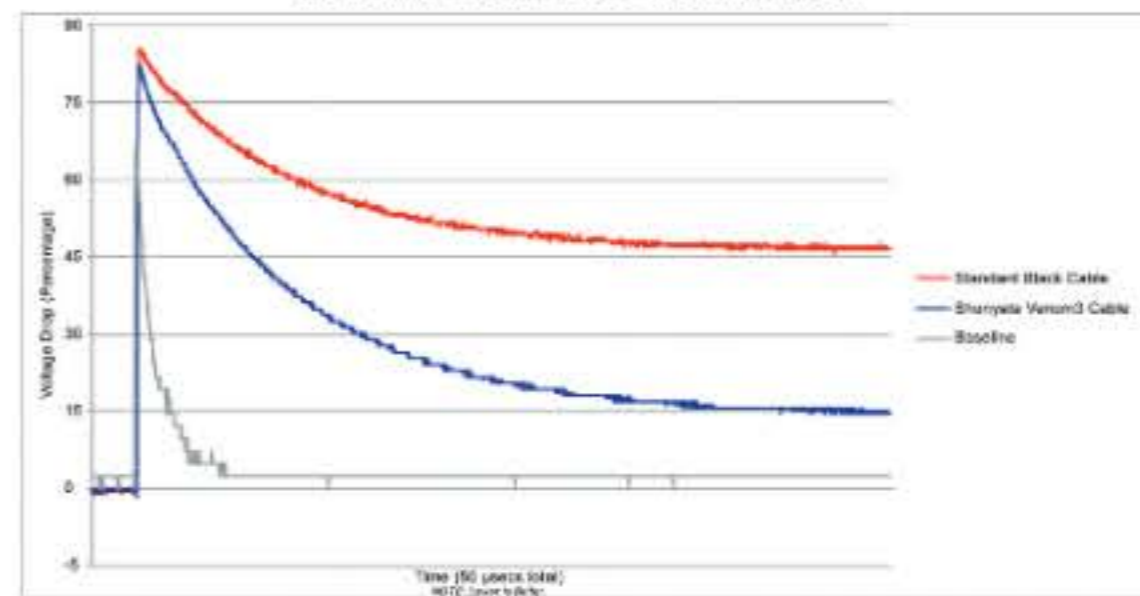


#### DTCD CURRENT MEASUREMENT:

This measurement depicts the difference in available impulse current between *Shunyata's* Venom-3 power cord (\$99 retail) and a standard black component power cord. Note the enormous difference in the quantity of current available compared to the stock power cord. The stock power cord delivers only 47% of available current compared to 84% with a Venom-3 power cord. By any standard of measure, this is statistically significant.

See more measurements and complete info at [shunyata.com/Content/dtcd.html](http://shunyata.com/Content/dtcd.html)

DTCD VOLTAGE DROP COMPARISON



#### VOLTAGE DROP COMPARISON:

The voltage drop depicted for the stock power cord was so profound that several models were tested to validate the standardized measurement. A 15 volt drop in voltage during the conduction period compared to only a 5 volt drop with a *Shunyata* Venom-3 power cord represents a night to day objective difference. This magnitude of difference is certainly significant in a high performance entertainment system.

NOTE: Many standard cords were tested. This cord is representative of the average measurement.



# DTCD White Paper

*Shunyata Research* designs and manufactures high-end power cabling and power distribution devices. We devote a great deal of time and resources toward researching all the materials and parts that go into our products. We perform many tests in an actual audio system to determine if there are audible differences between materials. Many other tests are performed with precision test equipment to see if there are objective scientific measurements that can be made to make correlations between the subjective tests and the measured results. We are constantly looking for differences between materials that might provide a performance advantage in our products, even if that difference is very small.

While many materials can be objectively measured, there are many that have verifiable performance differences in subjective testing that cannot (or are very difficult) to measure with test equipment. *Shunyata Research* owns virtually every type of power-line test equipment available and these are all used in our research. Unfortunately, even the most esoteric devices are incapable of resolving differences between some types of materials that are clearly different in subjective testing. This led to our experimentation with other types of test equipment not commonly used for cable testing in the context of AC power delivery. While some of these tests have proven to be useful, none could objectify the difference between, for one example, a six foot AC power cable — one being a 16 gauge and the other being a 14 gauge version. With that relatively short length of wire, no known test device could distinguish between the two. However, in subjective listening tests the differences were obvious.

At this juncture we began to look at the operation of the power supplies within consumer audio and video products. We knew from power analyzer tests that a typical power supply could generate current harmonics above the 50th harmonic of the power line frequency. This implied that there may very well be high frequency events in the current domain that could be causing audible differences between cables. We used a high-powered audio amplifier as a test subject. We looked at the AC input to the power supply and at the current and loads across the rectifiers (electronic switch) using current probes and spectrum analyzers. To our surprise we found that the rectifier “on-time” was different when different types of power cables were used. Further, we found different spectral signatures with different cables. After many months of testing we found that the results of the test comparisons were not always consistent and repeatable. The input voltage from the wall outlet to the amplifier could vary based upon time of day and other loads within the building. The test could vary depending upon the load on the amplifier and the specific heat that the amplifier was generating. For these and other reasons, we decided to create a precision reference test rig that would simulate the power line voltage source and a test load that closely simulated the action of a typical power supply under load. If we could build such a device it could provide us with test results that were repeatable and calibrated. This would allow testing of a power cable or other AC power device directly without having to run tests on an amplifier and then interpreting the indirect results. Thus, the concept for the DTCD Analyzer was born.

The DTCD Analyzer was designed to detect instantaneous current delivery in the context of a typical power supply as the load device. Why instantaneous current; because all modern power supplies pull power in current pulses. Consumer electronics devices have power supplies that use rectifiers to convert AC current to DC. Since these supplies use capacitors to store energy, the rectifiers only switch on when the input AC voltage waveform exceeds the stored voltage across the capacitors. This means that the power supply pulls current in a pulsed fashion — only turning on for a fraction of the total waveform period. The actual time period that the power supply is pulling current is what we refer to as the “conduction period”. It is only the conduction period that we are concerned with in the context of measuring current and voltage. We do not want an averaged reading of the current drawn during the entire power cycle, because that would obscure the actual performance of the tested items.

The DTCD Analyzer is designed to test a single current pulse through the DUT (device under test). Since the primary purpose of DTCD Analysis is to measure devices that inherently have very low impedance, it is challenging to create test equipment that can accurately measure differences between what is essentially wire and contact surfaces. Further, it is important that the differences have some relevance to the task that they are intended for.

With that in mind, the DTCD Analyzer needs to simulate the power grid as a constant voltage source. The DTCD Analyzer’s voltage source consists of a capacitive array whose characteristics include ultra-low impedance, resistance and ESR (measured at 0.0016 ohms) with the ability to provide peak currents of several hundreds of amps with minimal voltage drop.

The second major element of the DTCD Analyzer is the load. It was designed to mimic the action of a typical power supply when the rectifier turns on and off to fill the storage capacitors. It is for this reason that the source voltage is 30VDC, which is a reasonable voltage differential between line input voltage and the stored voltage level across the power supplies storage capacitor array.

Third, a detection circuit was created to accurately sense the voltage and current waveforms that occur during periods as short as only a few microseconds. The detection circuit in the DTCD Analyzer consists of a precision current sense, non-inductive resistive array.

Prior to the DTCD Analyzer, no AC measurement device existed that could define objective differences in wire gauge, geometry, terminations, connectors, outlets, distributors and more. This ability to quantify foundational performance characteristics within electrical delivery components represents a scientific breakthrough; one that will benefit sound and video based systems in many industries, from medical and military to recording and mastering. For the first time, a measurement exists that can quantify the most significant performance characteristic of any AC delivery device and its ability to serve the primary function of A/V electronic power supplies.

