

David Navone talks tech with Crown's crown prince of power, GERALD STANLEY, the man behind JBL's massive GTI series amplifiers.

ROYAL CROWN

REVIEW



Gerald Stanley has been with Crown for nearly 40 years. He started his career in electronics by listening to short wave broadcasts on old radios that he repaired by scavenging parts from other old radios. Working on RF (radio frequency), IF (intermediate frequency), and AF (audio frequency) stages, Stanley's youthful hobby led to a long-standing interest in engineering design. When he reached high school, Stanley started working on vacuum tube power amplifiers with high-feedback circuitry for the home audio systems of friends and family.

Back in 1964, while a student at Michigan State, Stanley began working for Crown in the tape recorder sector. (This was Crown's main business back then.) Designs of the mid-1960s incorporated transistors rather than vacuum tubes and Stanley worked as a draftsman and power amp designer on Crown's first transistor components — including power



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amps for the tape recorders. In 1966, the University of Michigan presented Stanley with a graduate degree and he began full time work designing power amps and tape recorders for Crown.

Since that time, Stanley has designed tape recorders, signal processors, audio amps, magnetic resonance gradient amp, and semiconductor and audio test equipment — including the Crown TEF. (We use the TEF for acoustic measurements in our Autosound 2000 Test Lab.) One rather unusual project of Stanley's was the design of a speech rate translator that was used by the courts to review hours of the Nixon tapes at higher than normal speeds.

AUTOMEDIA recently had the opportunity to sit and talk shop with Gerald Stanley.

With Harman International's acquisition of Crown in 2000, it certainly didn't take long for the introduction of the JBL A6000GTI 6000-Watt power amplifier. Why was this \$6000 amplifier the first Crown designed entry into the mobile audio market?

The 6000 is a statement piece that's intended to not only set performance records, but to make it obvious to all that JBL is not just another auto amp maker using the same tired old amp technologies that have been in play for decades. The 6000 uses a new robust switch-mode technology that allows higher voltage than has ever been seen in the auto. The technology, BCA, is short for balanced current amplifier. There are simple explanations of this class-I technology on the Crown Web site www.crownaudio.com. A more detailed description can be found in US patent 5,657,219 and an IEEE Transactions on Power Electronics article Vol. 14, no. 2,

March 1999 pg. 372-380, titled "Precision DC-to-AC Power Conversion by Optimization of the Output Current Waveform - The Half Bridge Revisited".

What's unique about the operating parameters about this amplifier?

The amplifier (monaural) has +/-165 - Volt DC rails that power two 3 KW BCA half-bridges. This allows three modes of operation:

1. Two high-voltage amps each driving 2-4 ohms with 160V+ peaks.
2. A single bridged output driving 2-4 ohms with 320V+ peaks.
3. A single paralleled output driving 1-2 Ohms with 160V+ peaks.

The latter mode is proprietary as ultra-low output impedance amplifiers are paralleled without requiring ballast or producing high circulating currents. The output impedance is not impaired to attain this mode of operation. (See U.S. patent 6,297,975.)

Does the JBL A6000GTI amplifier use Crown's Grounded Bridge Output Topology? If yes, please elaborate. If not, why not?

Grounded bridge technology is not required when you're able to produce high-voltage stages directly from half-bridge topologies. Common class-D designs cannot reliably attain high voltages with usable fidelity due to failure modes found in all high-voltage MOSFETs. The BCA design prevents current flow in the body diodes of it's MOSFET switches and thereby avoids the failure mode entirely. Dissipative amplifier designs suffer from thermally driven failures such as secondary breakdown and over heating.

In industrial settings it's common to place full-bridge switch-mode amplifiers in series for increased voltage. Grounded bridge operation is a member of this class of operation. The target peak output voltages may be in

the thousands of volts in these settings.

What are the power requirements for this huge amplifier and how can they be met by in a car audio installation?

The power requirements will require the addition of a 600-Amp (cold cranking) battery at a minimum. The longer the desired run-time at high power, the more batteries that will be required. If power draw is to be sustained at high levels, then the alternator must be augmented as well. While the overall amplifier and its power supply will produce a very high 75 percent operating efficiency at high power, that's still a significant potential power draw.

Approximately how much long term average power will the JBL A6000GTI power amplifier draw when it's producing music at full power with a duty cycle of typical music?

The best rule of thumb is the 75 percent efficiency rule. Many ask amplifier efficiency questions based on "typical" music operation, but what is "typical" music for one user isn't even music to another.

How do you rate amplifier efficiency in your list of important design considerations?

The larger the amplifier and the more limited the supply of power, the more important the efficiency issue becomes. For a 6 KWatt amplifier ,it's very important on both counts.

Can you explain the benefits of Crown's Dynamic Bass Optimization when compared to typical Bass Boost circuitry? Is the DBO circuitry used in car audio power amplifiers designed by Crown?

The DBO has it's origins with JBL, not Crown. Experience has shown that

equalization is typically needed to optimize the in-vehicle response of high BL product drivers in an often resonant environment. In the final result, it's always the listener that's the judge of what is best and that can only be attained by giving flexibility.

Back in the late 1980's, Richard Clark used a pair of Crown car audio power amplifiers in his IASCA-dominating Cadillac. What can you tell us about the design of this early Crown amplifier and, also, what happened to the distribution?

Crown can be rightfully accused of not having taken the car audio market seriously. For a brief period of time, Crown sold a product wherein we'd contracted the design and had it made in Taiwan. It was a conventional class-AB design with a switch-mode power supply. Not having been willing to develop the market, we simply pursued more profitable things, such as making gradient amplifiers for MRI.

At Autosound 2000, we have a six amp set of your 10,000-Watt Crown - Techron power amps in our test lab. We configure them in series and parallel for various tests and they're incredible. Did you have anything to do with the design of those monster amps?

Yes, I was the main designer of these amplifiers that owe their heritage to an industrial line of amplifiers made for medical imaging in MRI machines. Very large high-performance amplifiers are used to drive the whole-body gradient coils of such machines. The BCA technology was also created to first make gradient amplifiers.

Will Crown-designed car audio amplifiers use ODEP (Output Device Emulation Protection) circuitry? Is so, what will this do for performance? If not, why not?

Junction temperature simulation or ODEP can be applied to switch-mode amplifiers but is of less importance compared to its value in dissipative amplifier designs. It's better to make less heat than to optimize and protect dissipative processes.

When will installer-programmed adaptive signal processing be included in the design of power amplifiers? The idea here is that various speaker parameters could be programmed into the amp's processor so that we could get 100 percent speaker performance — with no danger of destroyed speakers. Any thoughts here?

As to when, I cannot say. But, it is true that more can be done with digital signal processing to protect and dynamically equalize loudspeakers than is being done today.

How did you get involved in designing audio components? Can you tell us some of the highlights of your career?

If you jump on Google (www.google.com) and search on my name you'll find a couple of interviews that have been done that give some of my ancient history. I started in the vacuum tube era, and moved on to the dissipative solid-state designs and am now in the third major generation of audio power — the switch-mode era. It's been fun.

How large do you think car audio amps will end up in the next 10 years? What are the practical limits?

The adoption of 42-Volt DC electric systems will be helpful to making larger amps as the 6000 presently uses a 0-gauge power feed. Just as higher voltage audio output makes the distribution of low-loss audio more practical, so will higher voltage input power. **Do you think we'll ever see the day**

when the loudspeaker will be in a "closed loop" with the power amplifier as opposed to running them "open loop" as we do today?

Yes, there will be some closed loop systems, but note that they'll encourage "canned" solutions which will reduce the configuration options that the customer will have. As an interesting historical note, see U.S. patent 1,822,758. In 1929, after Harold Black first invents negative feedback, the patent office issued this patent to Pierre Toulon wherein is shown the first use of closed-loop on a loudspeaker. Toulon's patent on negative feedback was actually issued before Black's but he did not file first.

Since you started designing high powered amplifiers, what amplifier components have experienced the greatest advances?

The active elements have undergone the most advancement. All power designs are limited by the performance limits of the tubes, bipolar transistors, MOSFETs, etc.

Many car audiophiles feel that subjective testing of amplifiers shows that size is the most important factor in sound quality. Do you agree or disagree?

Size is a vital part of the system, but brute size alone is not sufficient. Fidelity is always required. Switch-mode amplifiers are very old — the first instance can be traced to Burnice Bedford in 1930, U.S. Patent 1,874,159. Not until recent years has their fidelity been adequate to be used in high-performance audio. To that end, the BCA design leads the charge.

Our thanks go to Gerald Stanley for taking the time for this interview. We're looking forward with great interest to Crown car audio components and Gerald Stanley designs.

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