White Paper

Q-SYS™ CX-Q SERIES

Output power capacity **explained**

overview

Determining the true output power capability of a given loudspeaker load with today's high power amplifiers has several facets. You have to consider everything from the AC power outlet (and its circuit breaker) that powers the amplifier, all the way through to the load. Each "link in the chain" has a maximum limit that determine output power limits under various conditions. We'll look at the links in the chain to see how each contributes to maximum amplifier power output.

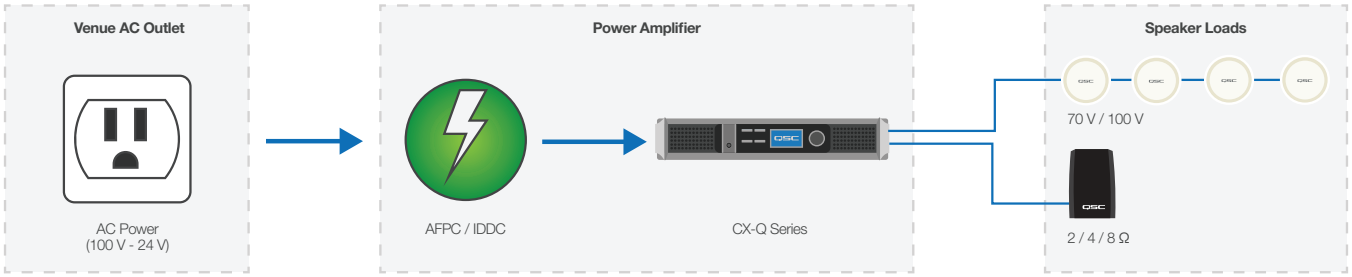

Figure 1 - Amplifier Power Chain

the AC wall outlet – where it all starts

The current available from the AC outlet, based on the circuit breaker rating on the circuit, is the ultimate limit on the amount of continuous power to a speaker load. Irrespective of the AC voltage and breaker current rating, the continuous power available from the AC circuit is:

power (Watt) = voltage (V) x current (A)

A 120 VAC 15 A circuit (common in homes) can supply 120 x 15 = 1800 W continuous power. Similarly, a 240 VAC 20 A circuit can supply 4800 W continuous power.

the takeaway: Selecting the AC supply for amplifiers is very simple – if there's a choice to run the amplifier on 120 VAC or 240 VAC – use 240 VAC (or the highest voltage available up to 240 VAC). For the same circuit breaker current limit, 240 VAC will supply twice the continuous and peak power capability as 120 VAC, and will give greater amplifier headroom under high output conditions.

the power supply – heart of the beast

An amplifier's power supply is a key component of the overall amplifier performance. The power supply converts the AC input power from the wall to isolated DC rails to drive the amplifier section. Electrical isolation is a safety measure to insure no user accessible parts of the amplifier are electrically connected to the AC line.

Many of the high power QSC amplifiers, including the Q-SYS CX-Q Series, use a modern switching power approach called Active Power Factor Correction (APFC). APFC, using high frequency switching technology between 50 kHz – 100 kHz, actively shapes the AC input current so that it follows the AC input voltage. APFC works properly on any AC input voltage between 100 V and 240 V, so no 120 V / 240 V switches are needed for the amplifier to operate flawlessly worldwide. Since APFC is most efficient in converting from higher AC input voltages, this is yet another reason to run these amplifiers from the highest AC voltage available (up to 240VAC).

the takeaway: The CX-Q Series amplifier power supply is very robust but every design has limits. For example, the Q-SYS CX-Q 4K4 can provide 4 x 1000 W on a short term basis, but *continuous operation* (approximately five minutes operation before protection measures reduce the power) is thermally limited to about 2500 W. This design approach gives the best amplifier performance for speech and music at a reasonable cost and physical size of the power supply – even when the system is turned up to eleven!!

the amplifier – where the rubber meets the road

Like the power supply, the power amplifier section has voltage, current and thermal limits that establish maximum power output under various conditions.

The easiest limit to understand is an amplifier's maximum voltage output – it cannot product greater output voltage than the DC supply rails that power it. For amplifiers like the CX-Q Series that must directly drive 100 VRMS (141 V peak) for distributed systems, the DC supply rails are set to +/-150VDC to allow for voltage losses across the output devices and output inductor. If there were no other limitations aside from voltage rails, a CX-Q Series amplifier could supply 1250 W at 8 ohms, 2500 W at 4 Ω and 5000 W at 2 Ω. Clearly other limitations are at work here.

An amplifier's output current also is limited to protect both the load and the amplifier's output devices. Current limiting makes itself apparent anytime an amplifier's maximum output power decreases with decreasing load. The table in Figure 2. shows the peak output currents that a single channel of the CX-Q 4K4 can provide. As you would expect, the output power increases as the load is decreased from 8 Ω to 4 Ω. However, the output power decreases as the load decreases from 4 Ω to 2 Ω, and this indicates the amplifier is near its current limit driving 2 Ω.

The CX-Q Series amplifiers also provide sophisticated thermal protection for to eliminate the possibility of damage to either the amplifier or the load using load current and voltage measurements along with thermal models in DSP of the real characteristics of speaker thermal performance. This thermal protection allows the amplifier to operate safely and continuously under the most demanding conditions of program material and speaker loading. Intelligence built into QSC's thermal protection algorithms avoids temporary amplifier thermal shutdown or catastrophic failure while keeping the music playing.

Clean audio – good… fire in amplifiers and woofers – bad.

the takeaway 8 Ω and 4 Ω loads take best advantage of the output voltage and current capabilities of the CX-Q 4K4, whether the amplifier is in independent, parallel or bridged mode. 2 Ω loads can be driven in independent or parallel modes, but the best "bang for the buck" in all modes is a 4 Ω load.

QSC CX-Q 4K4 Maximum Power and Current		
Load Impedance	Maximum Power	Peak Output Current
8 Ω	1000 W	15.8 A
4 Ω	1500 W	27.4 A
2 Ω	800 W	28.3 A

Figure 2 - CX-Q 4K4 Current Limits

wrap it up

Modern, high power amplifiers like QSC's CX-Q Series can provide enormous amounts of clean, reliable and efficient power for low impedance and high impedance loads. They can provide so much power that they can sometimes exceed the capability of the AC source. Some simple guidelines can help maximize the performance and service life of these amplifiers:

- Power the amplifiers with the highest AV voltage available in the venue, up to 240 VAC. This ensures the best amplifier efficiency and the lowest AC current draw for a given output power.
- Be sure the amplifiers have adequate space in front of and behind them in the rack so they are properly cooled. Although the CX-Q Series amplifiers are some of the most efficient in the industry, they still generate some heat. Proper thermal management is a must for long life, and also extends the time these amplifiers can operate continuously at higher powers.
- When driving low impedance loads, favor 4 Ω and above for best use of the full current and voltage capability of these amplifiers. Loads down to 1 Ω can safely be driven by the CX-Q Series amplifiers under some circumstances, but loads at or below 2 Ω don't get the absolute best these amplifiers can provide. If 2 Ω or lower loads are unavoidable, consider using the CX-Q 8K4. It's specifically optimized for very low impedance speaker loads.