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Fachmagazin für Veranstaltungstechnik



Review
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Compact PA QSC CP Series

QSC's most compact PA system encompasses a subwoofer and two full-range loudspeaker variants. Using modern DSP technology, QSC manages to provide very good audio performance from this small self-powered system



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Text and audio testing: Anselm Goertz | Photos: Dieter Stork, Anselm Goertz (1)

Once primarily known as a manufacturer of large-format PA amplifiers, QSC has since expanded to become a full-range provider of live sound products. Today, QSC offers a range of equipment solutions and products covering the live sound, installation and cinema markets. In the live sound sector, QSC sells digital mixers, power amplifiers with integrated DSP systems and a variety of loudspeaker products from compact loudspeaker to mid-sized line arrays. For the installation market, QSC's small music and paging mixers of the MP-M series are specialized for in-store applications and the food service industry. For large-scale applications, the company offers the Q-SYS system that is used and known worldwide. Accompanying the Q-SYS Core Processors are components such as page stations, loudspeakers, power amplifiers, control interfaces, cameras and much more. This allows QSC customers to build complete audio-visual systems for stadiums, conference centers and similar applications. We were provided with a newcomer to the live sound part of the QSC product palette, the CP8 active compact loudspeaker from the CP Series as well as an active subwoofer, the KS112. The CP Series currently consists of the CP8 and CP12 loudspeakers. Both can be combined with the KS112 or KS212C subwoofers. Both full-range loudspeakers come in a sturdy polypropylene cabinet with a multi-functional design, with an integrated carrying handle on the top surface. Each has a pole socket at the bottom for mounting them on poles, while suspending the loudspeaker from above is accomplished using an optional yoke mount. Carrying totes and rain covers for temporary use in wet conditions are also available for both models. The loudspeakers use either an 8-inch or a 12-inch woofer combined with a 1.4-inch HF driver, with a crossover at 2.2 kHz. One difference between the two models is the coverage spread for the tweeter horn. QSC says the CP8 version offers $90^\circ \times 90^\circ$, while the driver on the CP12 provides coverage across $75^\circ \times 75^\circ$. The typical use cases for the CP models are as mini PA systems with or without subwoofer, as DJ monitors or as floor monitors. For the latter application, the loudspeaker cabinet has an angled side. A special floor monitor setting is available in the loudspeaker's DSP.

QSC CP8 Compact Powered Loudspeaker

On its own, the CP8 is a genuinely compact loudspeaker easily carried in one hand. Holding it, you might barely believe that you're carrying a fully active two-way loud-



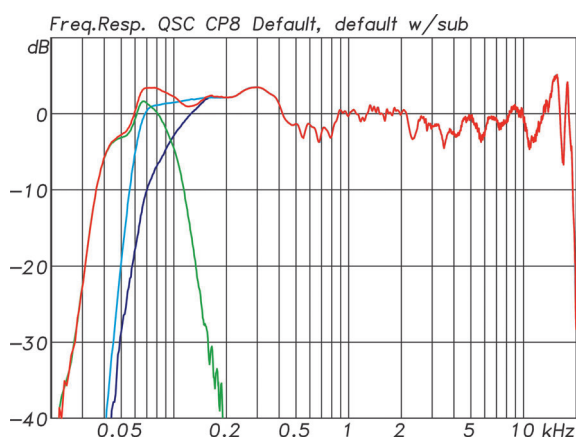
CP8 rear panel with integrated electronics and miniature mixer

speaker with an 8-inch woofer. The pleasing exterior with rounded corners can be easily stowed. Screwing off the front grille reveals the two drivers and a generously dimensioned bass reflex port. The latter is particularly important in avoiding port noise. A small horn has been integrated into the front panel for the HF transducer, but the rear panel is more interesting. Next to the power connection and on/off switch is a kind of a small mixer with three inputs

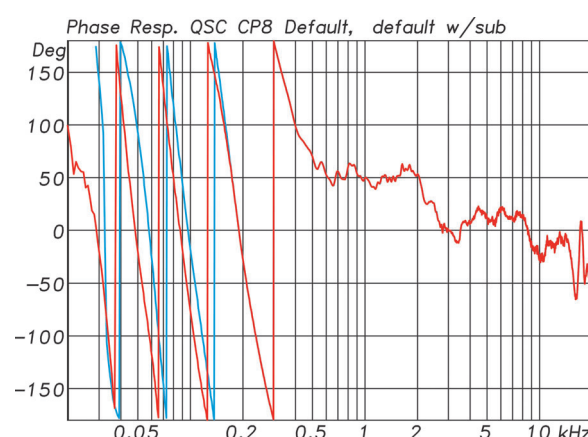
labelled A, B and C. Two Line signals can be mixed using the XLR/TRS combo connectors provided as inputs A and B. Input B can also be used as an instrument or microphone input (+25 dB) with additional gain. Input C is a stereo mini jack socket. Both channels can be summed to a single mono signal. These features let you, say, combine speech audio from a microphone with music coming from a phone or tablet with no additional accessories required. The XLR output provides the mixed summed signal from all inputs for use with additional loudspeakers or other equipment.

The selector switch lets users apply one of the DSP presets. These are: Default with/without sub, Dance with/without sub, Floor Monitor or Speech. Figure 1 shows the CP8's characteristics at the 'Default' setting with and without the subwoofer. 1. When used with a subwoofer, an all-pass filter is activated in addition to the high-pass filter already active in full-range mode. The all-pass filter lowers the volume around 60 Hz by 12 dB. The advantage of this type of filtering is that an all-pass filter has less of an impact on the phase relationship than if we change the frequency of the high-pass filter. Figure 2 shows the phase behavior. One noticeable characteristic is the phase shift in the bass area. This appears to be the effect of an additional all-pass filter designed to make it easier to use the CP8 with a subwoofer.

The CP8 is very useable without a subwoofer down to about 60 Hz. If we keep in mind that we're talking about an 8-inch loudspeaker, that's a very good value. The label "full-range" certainly applies here. Overall, the frequency response of the CP8 is generally balanced. The wide boost below 500 Hz seems somewhat unusual, though. Perhaps this is an attempt to balance the sound and give the loudspeaker more warmth. The rather unsettled response curve above 14 kHz probably results from partial movements of the HF membrane. But in this frequency range it probably has little or no audible effect. Looking at the phase response, we see a hardly noticeable, minimal phase shift at the crossover point between the HF and LF transducers. This suggests that a linear-phase FIR filter is used on the crossover. Our measurements for the vertical isobars (where we see little or no sign of the crossover), strongly points in this direction. We have no data, unfortunately, about the nature of the filters used in the CP8's DSP. Figure 3 shows how the CP8 behaves in the floor monitor setting measured at a height of 1.65 m on-axis to the loudspeaker. The Monitor preset turns down the bass response. The monitor "hole" at 500 Hz is moderate and is not compensated for. The effect of the slight response increase between 1 and 2 kHz on feedback is something users would have to check case by case and make adjustments as necessary.

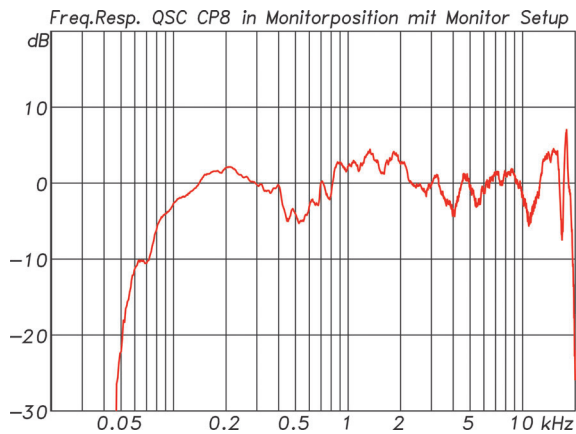


CP8 frequency response (light blue) with high-pass filter (dark blue), KS112 subwoofer with crossover at 80 Hz (green). CP8 and KS112 combines (red, fig. 1)

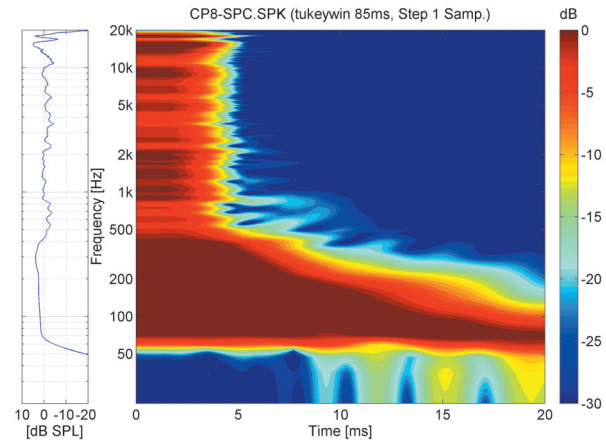


CP8 phase response in full-range mode (blue) and in combination with KS112 sub (red) Strong phase shifts appear as we go towards the low frequencies (fig. 2)

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CP8 in floor monitor mode (fig. 3)



CP8 spectrogram in full-range operation. The phase shifts in the low frequencies can be seen here as long decay trails (fig. 4)

Generally speaking, the spectrogram in Figure 4 shows low-resonance decay behavior. The only characteristic worthy of note is the long decay for bass frequencies. A pronounced phase shift visible in the phase response caused by an all-pass filter causes a strong increase in the group delay for bass frequencies, resulting in the long decay visible in the spectrogram. The group delay curve,

which isn't provided here, shows a maximum value of 32 ms at 60 Hz. The phase shift caused by the all-pass filter is a compromise we should weigh against the advantage it provides, namely a simpler and more flexible way of matching the loudspeaker to the subwoofers.

QSC KS112 Active Subwoofer



Along with a pair of CP8s, QSC also provided us with a KS112 subwoofer. It's designed as a two-chamber band-pass enclosure. The front and rear sides of the driver membrane each act as a resonator. The resonators then emit the sound via the two ports on the front panel. The balancing of the two resonators produces the sum of the band-pass frequency response. Figure 5 shows the measured near-field performance from both ports and their summing functions. Our measurements were made using the internal DSP set to a 100 Hz crossover.

Electronics module KS112 subwoofer



QSC KS112 subwoofer bandpass enclosure with two large ports for the resonators; their size and the rounded edges reduce noise at high SPLs

Without this additional electronic filter, we wouldn't see this perfect LF response above 100 Hz.

Fitted with a 12-inch driver, the subwoofer measures 622 x 389 x 616 mm (HxWxD), including the wheels. The KS112 can be used lying on its side or standing upright as a base for a full-range loudspeaker mounted on a pole. When lying on its side, the KS112 can be stacked using the feet on the bottom which slot into the matching fittings in the top of the cabinet. The cabinet is made from 15 mm plywood covered in textured black paint. Both top and bottom sides feature carrying handles. Inside the cabinet, the driver is accessed via the bottom panel.

The electronics package containing a Class D 2 kW amplifier is mounted on the rear panel. The deep metal case and additional side rails protect the connectors, display and user controls during transport. The module offers two inputs with direct link outputs. Signals from the two inputs are summed internally, so the KS112 can also be used as a mono subwoofer. A range of parameters such as crossover point, delay and setups can be adjusted using the display, two buttons and selection knob. The KS112 does not provide any high-pass filtered outputs. Signals are routed unfiltered to the full-range loudspeakers that handle signal filtering. The manual provides information about which crossover frequency (80 or 100 Hz) should be set for QSC full-range loudspeakers. For the CP8, the crossover should be set to 80 Hz.

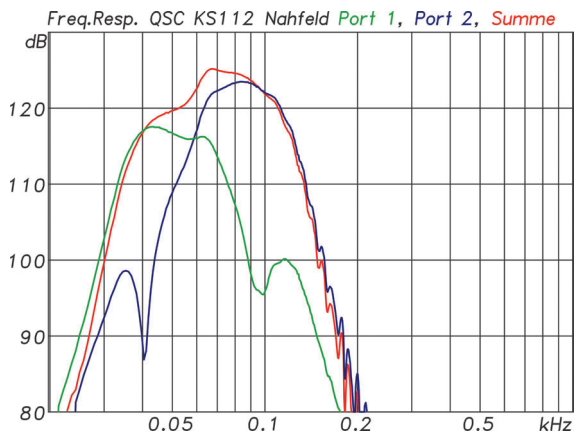
Figures 1 and 2 show how the KS112 performs together with the CP8. They show the KS112 individually but also as part of a full-range set up. The loudspeakers perform well in the crossover area where the two units are added. The lower cutoff frequency is now around 40 Hz. Between 50 and 100 Hz we see an exaggerated but presumably intentional increase of 2-3 dB, and we assume this is designed to exploit the performance of the loudspeaker without putting it under too much low-frequency strain.

We should also mention the second KS Series subwoofer, the KS212C. Compared to the KS112, the KS212C's cabinet is 240 mm wider. Toward the rear, there is an additional, second bandpass system, also with a 12-inch driver. Addressed by two separate power amplifiers, the two drivers are filtered so as to produce a cardioid directivity pattern in the low frequencies.

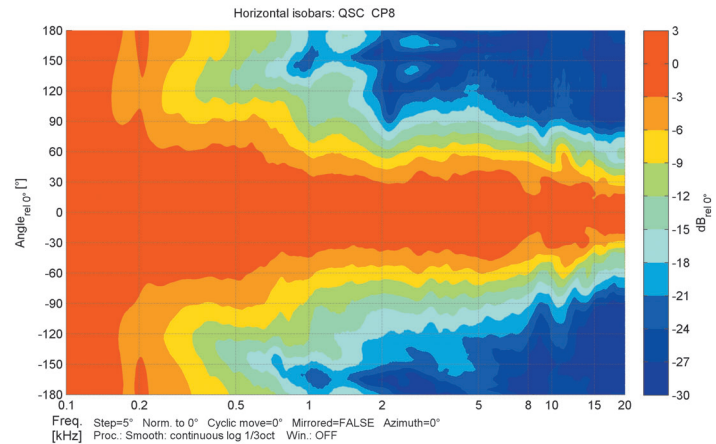
Directivity Matched Transition

DMT, or Directivity Matched Transition, is QSC's term for the ability of the loudspeaker to deliver directivity free of breaks, pinching or other irregularities in the dispersion pattern. The CP series is a good example of this. The CP8 has a 90° coverage angle, while the CP12's horn offers a 75° spread. With the same crossover, the 12-inch woofer focuses the sound more strongly than the 8-inch woofer. It requires a more tightly focused HF horn to give a smooth transition at the same crossover point. Figure 6 shows how well the 8-inch woofer and the nominal 90° HF transducer work together. In the horizontal isobars, the crossover frequency of 2.2 kHz is practically invisible. The average spread coverage angle of the isobars at -6 dB (transition

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Nearfield values for KS112 at 100 Hz crossover at both resonator ports (green and blue) and their summing function (red, fig. 5)



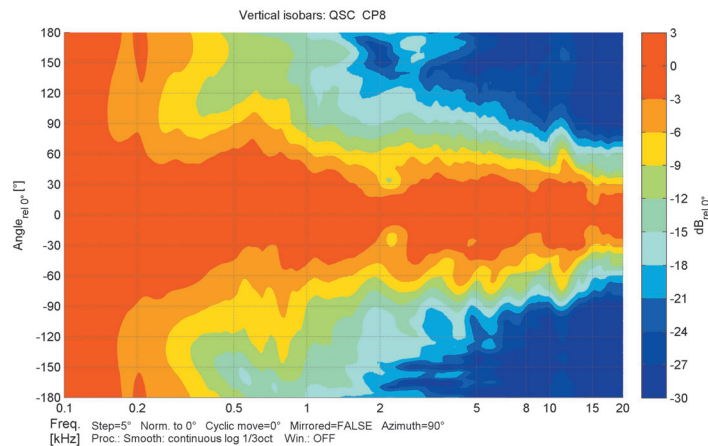
Horizontal isobars (CP8) with smooth progression and roughly 100° spread angle at -6dB (fig. 6)



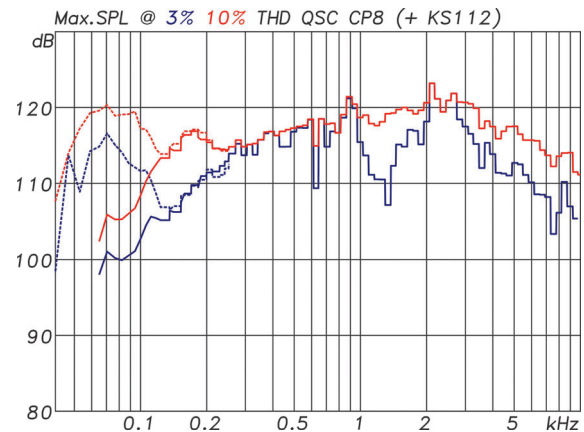
QSC CP8, front grille removed, with 8" woofer

from orange to yellow) is around 100° for the range above 1 kHz. That's slightly wider than the angle given on the official data sheet, which is 90°.

While that doesn't present too many problems for the horizontal plane, a multi-way system where the transducers are placed above each other does make things more tricky on the vertical plane. In addition to compensating for the directivity of the drivers, the angle-dependent delay for the summing in the crossover region also plays a role. This is why many loudspeakers show pinching or other irregularities in the directivity across a more or less wide frequency range in the region around the crossover point. Steep separation curves and linear phase characteristics can minimize these kinds of undesired effects. We don't know what types of filters QSC has used on the CP8, and finding that out would require quite time- and resource-intensive testing of the individual components. In any case, the end result is what you would want to see. The vertical isobars in Figure 7 shows almost perfect behavior. Around the crossover frequency, we can see a narrow pinching effect. The rest is just as good as the data for the horizontal plane. There's a slight asymmetry at around 600 Hz caused by the



Vertical isobars for CP8, the crossover point at 2.2 kHz is hardly noticeable, even taking into account the vertical relative position of the two drivers (fig. 7)



Maximum SPL at max. 3% (blue) and max. 10% (red) distortion, CP8 full-range (solid line) and with KS122 sub (dotted line) (fig. 8)



Accessories for the subwoofer

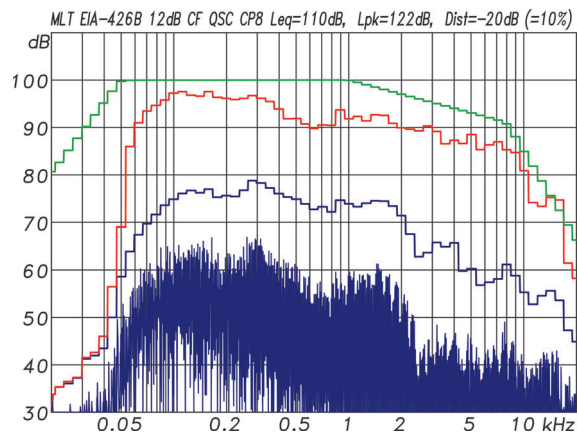
off-center vertical positioning of the LF transducer and by the bass reflex port.

Maximum Level

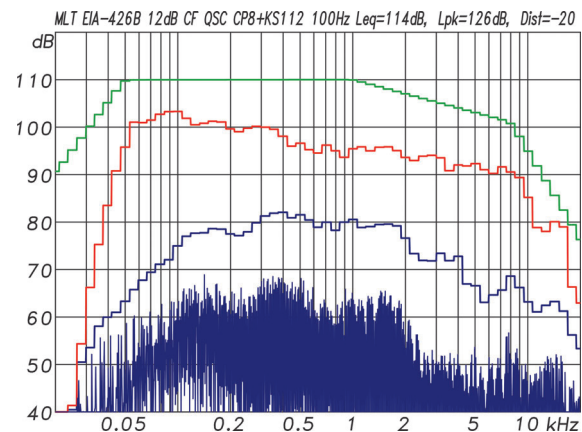
Given its size and price point, the QSC CP8 has another surprise in store in addition to its directivity. The measured maximum SPL proves that the CP8 is exceedingly powerful. The sine wave burst measurement method for the full-range loudspeaker at max. 10% distortion with no sub produces averages values of 117 dB above 120 Hz. Across the wide 1-3 kHz range, the output even reaches around 120 dB. Adding the KS112, the bass range extends down to 50 Hz at levels also close to the 120 dB mark. This kind of performance qualifies the little CP8 and the KS112 as a real mini-PA system.

The second series of maximum SPL tests is the well-known multi-tone method using 60 sine signals whose spectral characteristics can be freely assigned. For the results in Figures 9 and 10, the signal was weighted to represent a mid-focused music signal (green curve). The crest factor of this artificial measurement signal that describes the relationship between peak and effective values is around 12 dB for a value of 4.

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Multi-tone measurement for QSC CP8 in full-range operation. Overall SPL (red) with 110 dB averaged SPL and 122 dB peak SPL, 1 m distance in reflection-free environment, distortion component (blue) is -20 dB (=10% fig. 9)



Multi-tone measurement with KS112 and CP8 (note the scaling), overall SPL (red): 114 dB averaged and 126 dB peak, 1 m distance in reflection-free environment, distortion component (blue) -20 dB (=10%, fig. 10)

To derive the distortion values, all spectral lines are added that are not components of the incoming signal i.e. the harmonic or intermodulation distortion. Here, too, the volume is raised until the Total Distortion (TD) reaches the limit of 10% (-20 dB) or until limiters prevent the level being raised any further. In full-range mode, the CP8 delivers a peak level of 122 dB for a typical music-type spectrum using EIA-426B at 1m distance in a reflection-free, full space environment. The averaged SPL attained was 110 dB. Used in conjunction with the KS112 subwoofer, the system attained 126 dB peak and 114 dB averaged. The manufacturer's data sheet states 124 dB for the CP8 and 126 dB for the KS112, yet without providing any detailed information about set up or combination of full-range loudspeaker and subwoofer. The results of our tests add credence to the official values, which seem plausible and honest.

Conclusion

For the subjective listening tests, this little PA was set up in a reflection-free room. The impression we got during the tests were strikingly confirmed. This equipment can get really loud without the sound becoming intrusive or displaying weaknesses. Tonally, everything is fine, too. If we had to pick one thing worthy of criticism, it might be the bass when used with the subwoofer, which pushes too dominantly into the foreground. In practice, however, that

would be easy to correct by using an EQ. We couldn't really understand what the filter function implemented in the Dance preset was trying to do. But the Default preset is available as an alternative. Concluding with a look at pricing, the MSRP for the CP8 and KS112 are €449 and €1,099 respectively, both incl. VAT. Even without looking up what the "street" pricing is for a full set of two CP8s and one KS112, these are affordable, budget-friendly prices. This is a package you can invest in with peace of mind, and you get a lot of loudspeaker for your money.