User Manual - Crystal Dipole Loudspeaker

Revision 1.0

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Congratulations on your purchase of a unique and legendary open baffle dipole loudspeaker which uses two of the most musical dynamic drivers ever built - the spectacular Cube Audio F10 Select Full-Range driver and the powerful Eminence 15" Kappa Pro woofer.

As music lover's we feel that open baffle dipole loudspeakers can offer unique advantages for the music listener at home. Dipole speaker advantages are in both transparency and in a sense of spaciousness which provides a more realistic sonic presentation for many types of music. These characteristics are particularly apparent for acoustic music recorded live or in natural acoustic studio settings. The great Siegfried Linkwitz attributes these characteristics to the dipole power response of open baffle speakers which provides a sound devoid of early reflections off your listening room sidewalls which tend to muddle the direct response of the front wave of the speaker, coupled with enhancement of room reverberation effects which mimic what we experience with live music.

Dynamic drivers have the capability of generating displacements and SPL's an order of magnitude larger than planar film diaphragms (magnetic and electrostatic speakers) at low frequencies, however this capability comes with some drawbacks, especially the omnidirectional power response of the acoustic suspension and bass-reflex cabinets required to equalize the dynamic driver's inherent frequency response via Theile-Small parameterization.

The dipole characteristic is key to understanding the benefits and risks of adding a powerful dynamic woofer to any dipole speaker. ***While the incompatibility of dipole speakers and dynamic woofers has been ascribed to driver "speed" or other factors, the real issues are incompatible power response through the crossover region, and dynamic driver cabinet resonance and energy storage in the cabinet itself.*** These issues were identified and very successfully conquered for dynamic drivers by the late Siegfried Linkwitz whose LX521 open baffle dipole design remains one of the best loudspeakers ever built. Linkwitz realized that the use of electronically equalized dynamic drivers in specialized open baffle cabinets could provide flat acoustic response in real listening rooms without many of the problems that Theile-Small designed cabinets present. The VPE Crystal Dipole owes much to insights from Siegfried's pioneering open baffle loudspeaker work which can by found at http://www.linkwitzlab.com.

The VPE Crystal Dipole, Figure 1, is a unique full-range loudspeaker which combines the superb full-range Cube Audio F10 Select dynamic driver mounted in a felt-damped 20" x 40" x 1/2" thick acrylic baffle, with a DSP-equalized open baffle woofer with a difference.

Based on the legendary Pass / Linkwitz Slot-Loaded Open Baffle (SLOB) loudspeaker, the woofer cabinet is designed to present a high acoustic impedance mouth immediately above the floor, avoiding destructive "floor bounce" interference at the listening position. This legendary DIY design is now available in "turn-key" form for audiophiles who do not want to build their own.

Figure 1: VPE Crystal Dipole Woofer Front and Rear Views

The loaded slot provides increased acoustic impedance to the front wave of the dynamic driver, reducing the amount of equalization required to flatten the 15" driver's response for the frontal radiation which is emitted in-phase with the full-range driver acoustic response. The frontal response is ~3 dB higher than the back wave which comes off the back of the downward-facing cone and out from the behind the bafffle board. This is due to the acoustic impedance of the front-facing mouth. The cabinet itself is incredibly strong using 3/4" birch plywood panels, extensive bracing, plenty of "biscuits," glue and high quality fasteners to prevent cabinet wall flex radiation from distorting the speaker response. The cabinet may be finished with high quality cabinet paint, laminate or veneer, depending on your choice.

The VPE Crystal Dipole combines the slot-loaded cabinet with an excellent Eminence 15" fiber cone Kappa Pro dynamic driver designed with a Kapton coil former for high temperature and power handling as high as 1200 watts. A Dayton Audio SPA500DSP 500W amplifier, which incorporates one of the most flexible DSP-based electronic crossover and equalizer capabilities on the market, provides a low pass (60 Hz) augmentation to the Cube Audio F10 Select full-range driver. The Dayton Audio Class D amplifier and the Eminence 15" professional driver were both designed by for high performance bass production.

The 10" diameter Cube Audio F10 Select driver is a new derivative of the famous Cube Audio Neo neodynium magnet based driver. The F10 is designed for open baffle applications and has a ferrite magnet with a rubber surround providing long life and high performance. The proprietary spider construction and treated paper quadruple cone structure provides unmatched linearity and near-flat frequency response out to 20 Khz. Cube Audio describes the new driver on their website here:

> "The *F10 Select is the newest 10" fullrange driver. It opens the 10" line and is the easiest driver to apply in a DIY projects. Being a fullrange driver that requires no crossover while keeping high 8 Ohm impedance and 90 dB efficiency makes it perfect driver for any DIY design. We recommend bass reflex, TQWT or Open Baffle designs.*
>
> *The F10 Select driver has a ferrite-based magnetic motor and maintains the same magnetic field gap of 9 mm (as the F10 Neo) with an underhung design. The X-max value of both drivers is the same; thus, the cone control by the magnetic motor for F10 Select is very good.....We decided to aim for a sensitivity of 90 dB since it is the value that would work out beautifully with over 99% amplifiers on the market. The drivers have an impedance of 8 Ohms and are very easy to drive. Basically, any 8W SE 300B amplifier would be able to rock the house."*

The F10 Select driver is mounted on a 20" W x 40" tall acrylic baffle board that is fastened to the woofer frame using four large bolts and four EZ-LOK threaded inserts in the plywood uprights. The baffle is isolated from the frame using medium thickness felt dampers between the acrylic and the plywood. In addition, acrylic has twice the density (mass/volume) of plywood but only 1/2 of the plywood elastic modulus (stiffness) which results in much superior damping compared to the original Pass SLOB design. This greatly reduces the vibration that is created by the energetic woofer from reaching the full-range driver and impacting its response.

The crossover and equalization settings pre-programmed into your VPE Crystal Dipole loudspeaker woofer system were generated using pink noise to match the natural fall-off in the Cube Audio open baffle bass response from ~ 25 Hz to ~200Hz, with bass augmentation from the Eminence driver in our studio. Plots of the Cube Audio open baffle response, the woofer response and the combined response are presented in Figure 2, below.

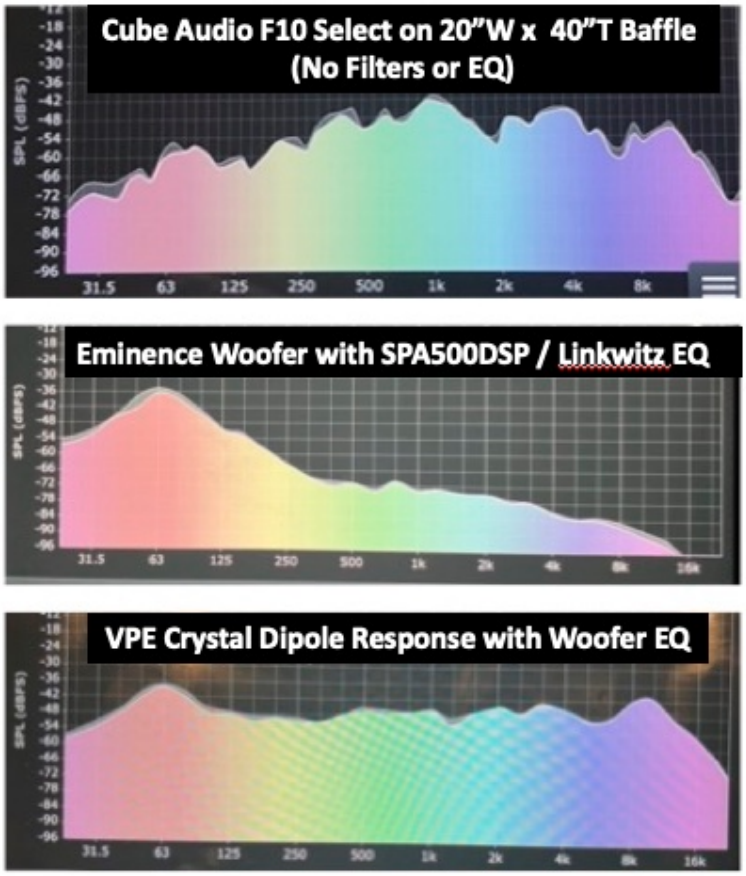

Figure 2: VPE Crystal Dipole Pink Noise Response with iPhone RTA

The VPE Crystal Dipole Loudspeaker integration of the F10 Select provides essentially the same frequency response as the excellent Cube Audio Jazzon loudspeaker which incorporates the F10 Select, but with more power and with a dipole polar response.

The default settings for the Crystal Dipole SPA500DSP amplifier and a screenshot of the excellent Dayton Audio DSP control GUI are provided below. This EQ curve is essentially the same as the used in the Linkwitz's LX521 dipole woofer. ***Consider it only a starting point !*** Note that the Eminence Kappa Pro driver is self-limiting in excursion as it was designed for professional sound applications (PA systems and Fender / Rickenbacker bass guitars), and needs no protective subsonic filter as employed in our other products.

You will find that the SPA DSP is quite powerful in tailoring your woofer's response to your room. Experimentation is encouraged to receive the best results. This system has been judged by our reviewers to be both better and easier to use than ANY woofer DSP available on the high end market today, and is especially well suited for dipole woofer equalization.

Section	Frequency	Slope	
Subsonic Filter (Opt.)	Bypassed	Bypassed	
Low Pass Filter (Woofer)	45 hz	24 dB / Octave	
High Pass Filter (Panels)	Not Applicable	Not Applicable	
Parametric EQ	Frequency	Gain	"Q"
1	10 hz	+6	0.6
2	20 hz	+2	0.6
3	30 hz	-3	0.9
4	40 hz	-6	1.0
5	50 hz	-12	2.0
HP Time Delay	0 ms		
Limiters	Attack 1.0 ms	Release 480 ms	Threshold 0 dB

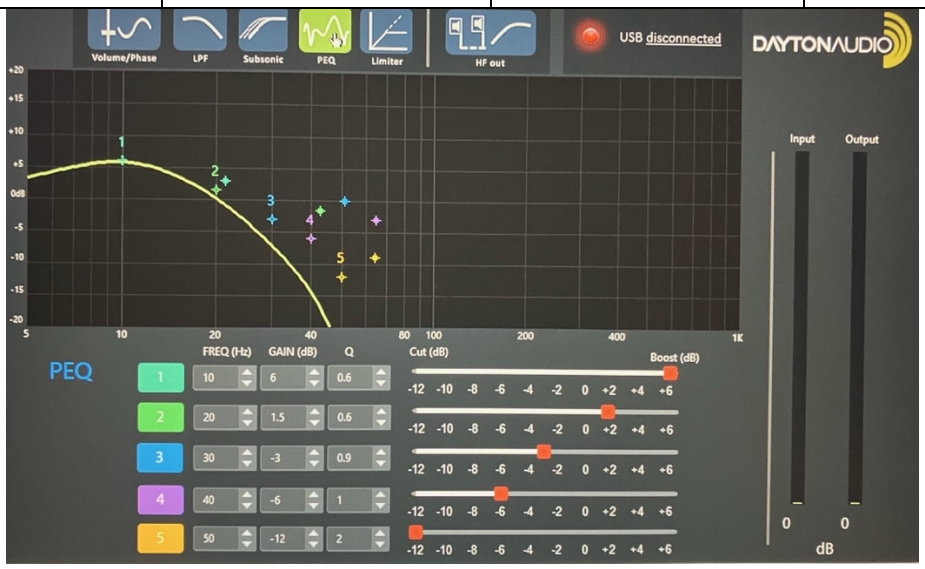

Figure 3: SPA500DSP Amplifier Default Settings

Two additional resources for determining your optimal DSP settings are 1) a calibrated pink noise source, the "Flat Pink CD4000" disc provided with your Crystal Dipole, and 2) Apple iPhone apps "Real Time Analyzer (RTA)" from Studio Six Digital OR "Octave Band RTA" from the Apple App Store. The built-in microphone in the iPhone is sufficient for setting the DSP levels, but Studio Six Digital also offers an excellent calibrated microphone which plugs into the iPhone Lightning port for power and data and which is compatible with both of these RTA's.

The correct SPL level match between the Eminence woofer and the F10 full-range driver is dependent on the voltage gain of your Cube Audio F10 Select power amplifier and the acoustics of your room. The Cube Audio F10 Select driver is quite efficient at 90 dB for 1 watt of power. As Cube Audio states, you can "rock the house" with single ended 300B tube-based amplifier (about 8 watts). You should never need a full range amplfier with more than 20 watts of power. Recommended amplifiers include a number

of great single-ended 300B triode amplifiers, (Elekit 8600 / 8900, Cary CAD-300SEI, Wavac EC-300, Airtight ATM-300, Line Magnetic LM210, Decware SEWE300B), the Class A solid-state Pass First Watt J2, SIT-3 and F8, and solid-state Schitt Aegir "Continuity" amplifier.

Matched voltage gain levels can be verified using the CD4000 disc (Track 2), and an RTA. In the unlikely event you run out of voltage gain on the SPA500DSP amplifier, call us and we will send you a high quality voltage divider to insert between your preamp and your F10 Select amplifier to provide the woofer amp some headroom in voltage gain.

Using the woofer volume control, tune for level pink noise response from 250 hz down with some slight dropoff below 40 hz to compensate for room gain. Note a small bump at 60 hz is consistent with the F10 response as seen in a cabinet (Jazzon) and in an open baffle. Don't worry about it ! You won't really notice it with music. The Crystal Dipole woofer should not be apparent on its own - it should simply augment the performance of the F10 Select full-range driver when properly tuned and positioned.

The most expeditious way to program the Crystal Dipole DSP is use of the Dayton Audio's Graphical User Interface (GUI), a laptop PC and a USB-A cable to ties your laptop to the amplifier, as per the Dayton Audio SPA500DSP User's Manual. (Sorry, Mac fans, the GUI is only compatible with the Windows Operating System.) **The GUI Executable can be downloaded directly from Parts Express / Dayton Audio website.** An alternative approach is outlined in the SPA500DSP User's Manual using the rotating button on the amplifier, the alpha-numeric display on the amplifier, and the flowcharts provided in the Dayton Audio manual.

The Crystal Dipole hook-up schematic is provided in Figure 4. The speaker ships with both RCA and XLR splitter cables which plug into the back of your preamp. The first leg goes to your F10 Select amplifier with NO high pass filter required. The second leg goes to the SPA500DSP amplifier left input jack (RCA or XLR) for the slot-loaded augmentation woofer. Pretty simple and NO "stinking" digital stuff or analog filters between your preamp, your power amp and your full-range drivers.

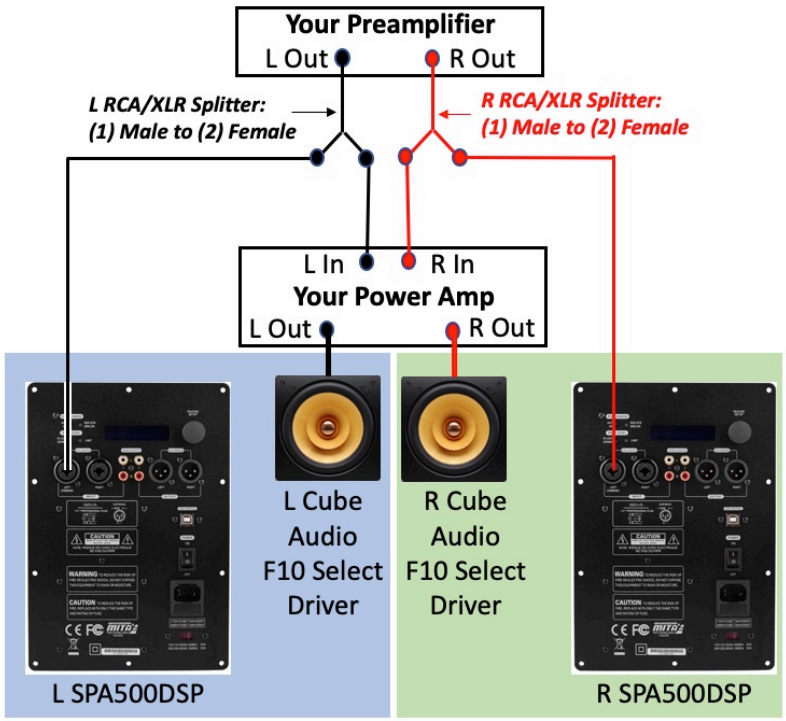

Figure 4: VPE Crystal Dipole Hookup Schematic

In an optimum set-up, your Crystal Dipole loudspeakers should be at least ~3' from the back wall. The speaker is designed for this positioning, but will also work further out from the wall. Use your pink noise disc and an iPhone RTA app to achieve a smooth response from 35Hz through 250Hz for your listening room using the SPA500DSP controls.

When you are finished you will have a loudspeaker the Big Lebowski (aka, The Dude), would find "abides" all your sweet music. It's unconventional, (Walter might not like it), but we know you will LOVE IT as much as we do.

We recommend Signal Cable RCA / XLR interconnects (www.signalcable.com), and Audioquest Type 5 or Kimber Kable 4PR or 8PR speaker cables for excellent performance at affordable prices.

VPE Crystal Dipole Loudspeaker Woofer Specifications and Drawing:

Overall Dimensions: 48" tall x 20" wide x 19" deep

Acrylic Baffle Board: 20" wide x 40" tall x 1/2" thick (Clear, Gray Tint, Bronze Tint or Solid Black)

Weight: 100 Lb.s

Footers: (4) Dayton Audio 1" tall spikes

Loaded Slot Dimensions: ~ 3" tall x 16" wide

Full-Range Driver: Cube Audio F10 Select 10" Treated Paper Quadruple Cone - 8 Ohms

Dynamic Woofer: Eminence Kappa Pro 15LF-2 15" Fiber Cone - 4 Ohms (1200 W capable)

Integrated Power Amplifier: Dayton Audio SPA500DSP - 500W into 4 Ohms

AC Power Compatibility: 120 or 230 VAC

Cables Provided: IEC AC Power, USB-A Data, (2) RCA Splitters and (2) XLR Splitter (1 Male to 2 Female Connectors)