# La Voice of the Theater Chez Nous

## Taming the ALTEC A5 Classic for Domestic Use

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**Bel Canto Design**

When I had the opportunity to hear Jean Hiraga's A5 system in the *Nouvelle Revue du Son* listening room with our *Orfeo 30*, 845 SE amp, I *instantly* knew that I had heard the system that could replace the Spendor SP-1s that have been doing the job in our living room for over 13 years.

Actually, the Spendors officially belong to my wife. She always had a suspicion, totally unjustified of course, that I would go out and sell the old reliable SP-1s in an audio frenzy.

I confess that it was love at first listen with the A5s. I mean I listened to a single bar and I *knew*. When I chose the Spendors it took me about 10 minutes of listening. It doesn't take me much listening to recognize a speaker I can really live with.

In any event, the decision to explore a large scale horn system has proven itself to be a positive step. Music has injected itself totally into our lives through these devices, they are, indeed, the other half of the wonderful music creating possibility of the SE triode amplifier.

No, they aren't perfect, although I am not yet certain if any weaknesses are a result of other system components or the recording or the speakers. These speakers make music completely engaging, without any 'High End' audiophile pretensions in the traditional sense.

Sure they aren't perfect (what is?), but they are so much better than any alternatives, and they play music so convincingly that I just don't really notice or care about weaknesses.

A properly set-up A5 system can make one forget about the little audiophile worries and just listen, becoming engaged with the music, whether Hendrix, Gould, Bizet (opera comes positively alive), Brel, Evans, Miles, Nina Simone, the Beatles, you get the idea, every artist communicates their musical potential through a system like this. The source can be CD, LP, radio or even an old cassette, you will still hear more of the music and the musician(s) than you ever have before.

I am not an audio reviewer, so I won't take apart the performance. Let's just say that they can do everything very well, some things better than any other system I have laid ears on. Overall, they are good enough to make other familiar systems seem Dead End. Instead they incite you to dance or laugh or sing or just shake your head in wonder at the musicianship of a performance.

Actually, after living with our customized version of the classic A5 Voice of the Theater system we have concluded that it would be just about impossible to go back to a more 'normal' type of loudspeaker.

### Jean Hiraga's System

How do they do what they do? As an engineer this is the first question that comes to mind when I experience something unexpected. This was what led me to the 845 triode and SE amplifiers some 10 years ago and it is happening again with these loudspeakers. I will describe the system that I heard in Paris and continue by describing what I have managed to assemble, looking at the parts before trying to home in on the whole.

M. Hiraga uses the 828 style bass/midbass cabinet with a Westrex (Westrex was the export arm of Western Electric/ALTEC) sourced 515B type 16" bass/mid driver below 500 Hz, a Westrex 2080 1.4" compression driver (Altec 288 C) comes in at 500 Hz and drives a 1505B, 15 segment exponential horn, and for large spaces he brings a JBL ring type tweeter in above 15 kHz.

The crossover/EQ design generously shared by M. Hiraga was essential for getting a loudspeaker which was originally designed to fill a large theater to make music in a reasonably sized home.

The third octave sweep from the system in France and the crossover circuit from M. Hiraga are shown below. It looks somewhat complex but is really quite a simple and elegant solution to the challenge at hand.

The crossover marries these two drivers very well, yielding a response that is remarkably flat in room from about 40 Hz to around 16-17 kHz. I did not use a ring tweeter, agreeing with M. Hiraga that it is not necessary in smaller spaces.

The 828 cabinet is a hybrid design using a short horn loading the 515 above 150 Hz. Below this it behaves as a reflex cabinet, using both the front and back waves plus room augmentation to get enough efficiency to match the short horn midrange. The result is about 100 dB/W/m down to around 40 Hz. This is very high sensitivity for domestic use, enough to get tons of sound out of a 3 watt amp.

Despite the high sensitivity of the A5 system, Hiraga prefers high power SE amps such as the 30 or 60 watt *Orfeo 845* amps, meaning he gets lower overall distortion, better bass and still has plenty of headroom for dynamics in his large listening room. He brings in the HF horn at 500 Hz with some EQ in the crossover to extend the upper end response to around 16-17 kHz and bring the overall efficiency in line with the bass cabinet.

The 1505B is mounted above the bass cabinet, phase aligned and directed down towards a listener about 12-15 ft away from the speakers. The Altec horn has a fixture which allows the vertical angle of the horn to be changed, permitting you to aim the horn at the listening height and blend it with the bass driver. The horn is not rigidly mounted to the bass cabinet, you can move it to align for best phase response with the bass.

The JBL super tweeter is placed well back on the external rear top of the bass cabinet, also phase aligned and firing at a 45 degree angle into the listening area. This fills the room with the high harmonics and reduces the directionality of the system.

Thanks to the extensive EQ in the crossover, a passive unit designed for use with one amplifier, the sound is very balanced. M. Hiraga changed the port opening on the bass cabinet to better align the reflex cabinet and he uses side mounted bass 'wings' to restore the low bass efficiency for use away from room boundaries. There is some strategically placed damping putty on the mid horn and there is a large thick felt blanket in front of the JBL to prevent reflections off of the cabinet top.

I find the whole assembly attractive in a purposeful industrial design, no nonsense kind of way. My wife has been convinced to live with ours, especially after hearing what they do for music, and a promise from me to clean up the finish a bit. It does take up space, to be sure, but it makes more and better music than any other system I have heard.

Despite the size, it won't go down to 20 Hz, that will have to wait for some kind of serious subwoofer system in the future. The rest of the spectrum reveals how uninvolving and uncommunicative most 'High-End' systems are. Not even taking SE triodes into the equation, this kind of speaker will get the most out of whatever goes in front of it. This is the direction that we need to go.

### The Logic of A5 Systems

So, what can we learn from Hiraga's A5 based system?

1) Use high performance, intrinsically linear (i.e. low distortion), high efficiency, drivers and cabinets.

2) Avoid overly extended or resonant cabinet alignments.

3) Use as wide a midrange bandwidth as possible, avoiding crossovers in the 1000 to 3000Hz region. The special qualities of this loudspeaker are in part due to the use of only two drivers for full range response.

4) Phase align and focus the driver alignment.

5) Pay attention to response smoothness over absolute maximum efficiency, 96-100 dB will be enough for virtually any domestic situation even with only a few watts.

6) Make sure the upper harmonic energy is there and can get around the room.

7) Don't worry too much about the lowest octave, especially at the expense of the upper and mid bass performance. The low bass is where the mud starts. And above all, keep it simple.

I will now detail the speaker by addressing each of the above points and discussing specifics of my implementation:

### Driver Quality is where everything starts...

The 515 bass driver and 825/828 style cabinet are remarkable for their efficiency, bandwidth and low distortion. I used a 16 ohm 515E driver. This is the ceramic version of the 515B, the legendary Alnico driver.

The 515B and 515E apparently have less midrange output than the new 515G version. This is probably a good thing as there is about a 5 dB step from around 150 Hz up shown in the 515G documentation. This is great when projecting sound in a theater, through a screen, but it definitely needs taming for domestic use.

I personally have no problem with the ceramic version of this driver, the moving

1— According to Altec expert Gary Jones, the early versions of the A5/A7 bass cabinet were called 825, which was replaced by the 828 when the 515 switched from a 15" frame to a 16" frame in the mid-70s. The later woofers will fit in the 825 cabs because the mounting holes are slotted. The early woofers will not fit in the 828.

elements are the same as the 515B version and assuming the gap linearity and flux density is high enough I won't ever have to agonize about whether the Alnico needs to be remagnetized as they sometimes do after time or after a mechanical blow or overload. The 515s are great drivers in any version.

515s have enormous magnets and the 3 inch edge wound aluminum ribbon voice coils are underhung, which greatly increases the driver linearity. The 16 ohm version has a BL factor, which is a measure of the magnetic flux density times the number of turns of wire in the gap, of about 22 for the 515E. Contrast this with a good 8 inch High End woofer BL factor of around 5-8. This is remarkable for any driver and especially impressive in combination with the underhung design mentioned above. This gives an idea of the acceleration potential and the control that this motor system can provide.

The cone is a beautiful paper construction with a very stiff spider. You can push on the edge of the 15 inch cone and there is no rocking, just a linear movement of the whole cone.

The dust cap has a 1 inch hole in the center to avoid compression distortion and dust cap coloration and the damped, pleated suspension avoids the low level hysteresis loss typical of rubber surrounds.

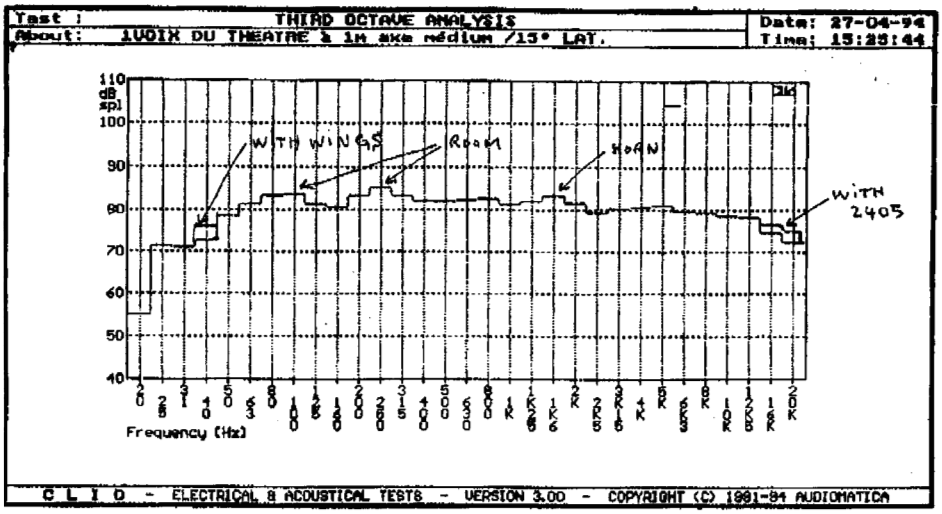
The frame is a masterpiece, with a 1 inch thick edge and massive support beam construction with little area to constrict the back wave flow. The 515E weighs in at a cool 30 pounds. There is really no other way to get the low distortion, high efficiency and impact that the 515 provides.

Altec 515s are not mongo PA speakers like many massive pro drivers. Rather, they are delicate instruments which can knock your socks off while they tantalize your subtler senses. They are true high fidelity devices and are rated to handle only about 75 watts of power, no power at all in today's pro speaker universe.

The upper half of the acoustic spectrum is handled by a wonderful driver and horn, the 288K-16 1.4" throat compression driver and the 1505B horn. The version of the 288 that I am using is a newer ceramic magnet 16 ohm unit with the Tangerine precision cast metal phase plug. It goes even higher and cleaner than the older Alnico drivers, making the JBL super tweeter even less necessary.


**Above: the A5 system that changed my mind. Jean Hiraga's reference loudspeakers at *La Nouvelle Revue du Son* in Paris**

**Below: Third octave sweep of frequency response showing contribution of extension "wings" and JBL tweeter.**



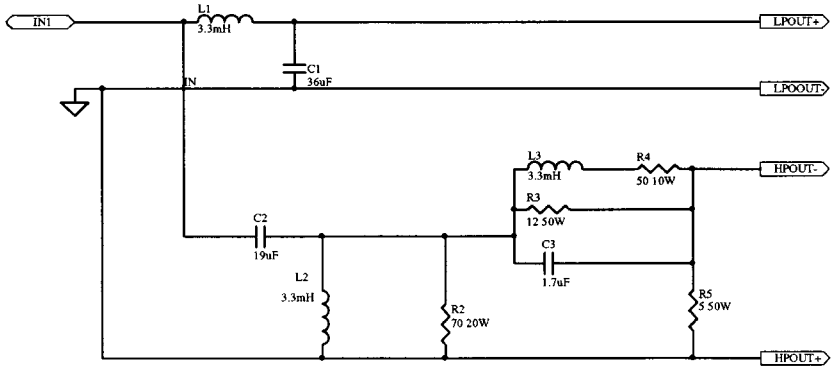

The 288K uses a 2.8 inch diameter concave aluminum alloy dome with integral tangential suspension and edge wound aluminum ribbon voice coil. This "tweeter" weighs 30 pounds giving an idea of the construction quality and magnet size! It has 20,500 gauss flux density in the gap (as much as a Lowther).

The 288K's maximum excursion capability of only 0.035 inches indicates that it is designed to operate without any diaphragm breakup throughout the frequency band and up to very high levels.

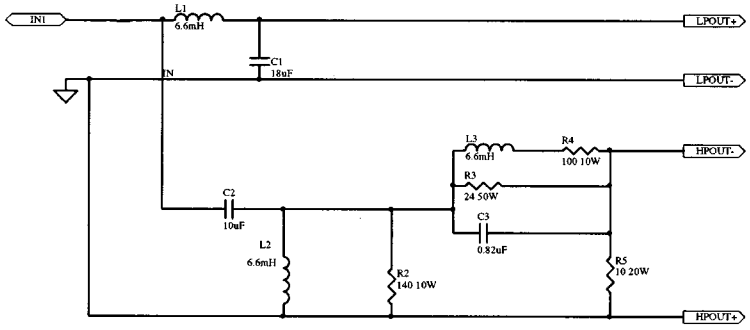
When coupled with a horn like the 1505B it has 112 dB/W/m sensitivity in the 1-5 kHz band! The response drops above this to about 103 dB at 16-17 kHz.

Be sure to pry out the bug screen that these drivers have to protect them in pro use. On the other hand, if you are buying some used you may want to be sure the screens are there if they have been used professionally.

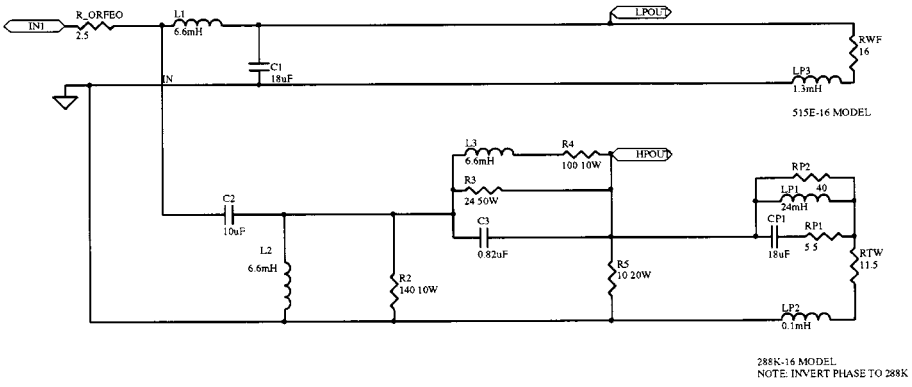
Altec still supplies diaphragms for most of these compression drivers and they can repair, recone and remagnetize most old




**Jean Hiraga's crossover for 8 ohm drivers**




**Crossover component values scaled for 16 ohm drivers from Hiraga's original design**




**SPICE simulation schematic, including models of 288HF driver, 515 woofer, and simulated output impedance of Orfeo SE 845 amp**

cone drivers. The record shows that these puppies can last for over 40 years in auditorium and theater use with virtually no service.

The 288 driver and horn is designed to play at peak levels up to 128-130 dB although its continuous power handling is only around 15 watts. Like the 515 it inhabits a different world from typical "hi-fi" drivers.

Both the low and high frequency horns have controlled directivity with 120 degree horizontal for the high frequency and 90 degree for the low. Both horns have 40 degree vertical dispersion. These dispersion figures mean that they can nicely fill a room but they won't tend to interact as a direct radiator but more like a panel speaker for ceiling and floor reflections.

The very wide dispersion of the 15 cell exponential high frequency horn removes any tendency to beam high frequency energy and cut off your head as many horns can.

The 1505B deserves more description. It is a very large and impressive looking device made from 15 individual exponential horns which come together in a complex assembly having over 3 square feet of radiating area. They are specified for use in theaters with over 400 seats! In my 450 square foot listening room they are barely breathing.

These exponential horns are designed assuming a planar wave launch from the compression driver. It is the job of the phase plug to align the acoustic phase off of the concave diaphragm to approximate a planar wave launch into the driver throat.

The horn really begins with the phase plug. The "Tangerine" plug used in the 288K is a beautifully formed metal piece and allows much of the diaphragm to remain visible through the center of the horn. It appears that the 288 uses about a 2:1 compression ratio through the phase plug. This helps to keep distortion low at high levels and the clear acoustic path helps high frequency extension and clarity.

The 1505B uses long cells to get good low frequency extension with 15 cells in three rows of 5 and a small mouth opening on each cell to get good high frequency extension and dispersion.

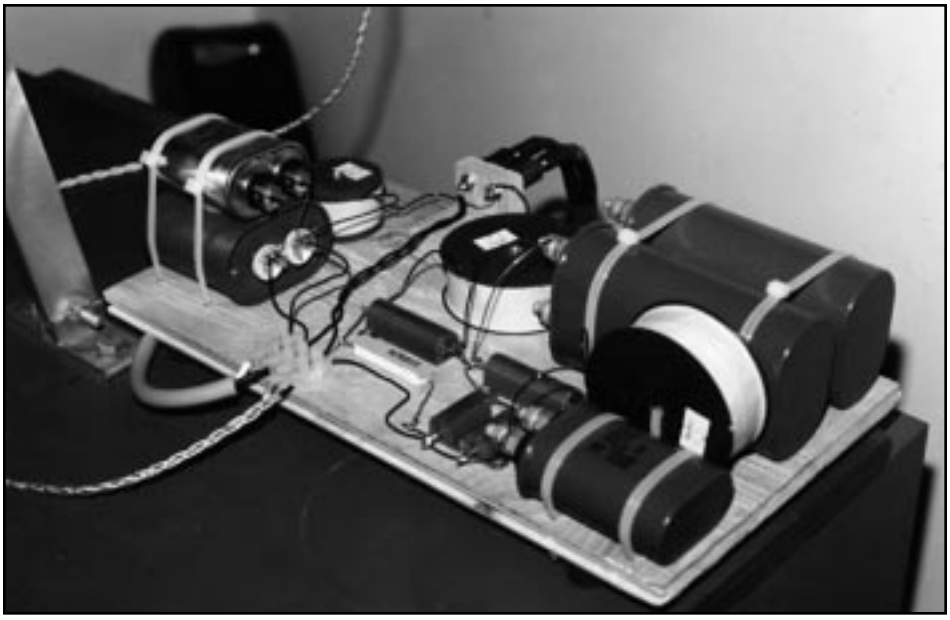
Each individual cell is a hand made aluminum construction with some sort of material like car undercoating used to

dampen any high Q resonances. This is a very effective method and I have had no desire to further dampen this horn.

I hate to think of how much these horns would cost to produce today. They are the only part of this system which cannot be bought off the shelf. If you find some extras, let me know...

I suspect that the enormous mass difference between the moving elements of the 288K and the stationary parts of the 30 pound driver and 30+ pound horn make it doubtful that much energy from the diaphragm goes into resonating these structures. The ability of this combination to reveal natural detailing of harmonic structures and dynamic inflection argues in that direction.

This pair also has the sweetest high frequencies, much like a Maggie ribbon but with much greater impact and dynamic potential.



**Constructional Details of Crossover**

**Make the right tradeoffs in the bass...**

The 515 is designed expressly to work in a horn enclosure like the 825/828 cabinet. M. Hiraga has mentioned the golden number ratio when talking about the proportions of this cabinet. These proportions may be why it sounds good even unmodified, with little of the 'boxy' sound that many bass cabinets have. It loads the 515 perfectly, newer ones have the correct volume and port area to allow optimum bass extension and efficiency.

Older ones will need to have the area behind the short horns closed off and the port area reduced by up to 50%. The cabinets that I bought allow some adjustment of the port area and I have set these to the minimum of 25 1/2 by 8 1/4 inches. This port arrangement is near ideal in that the depth of the port is only 5/8", the thickness of the panel. The usual port turbulence and airflow noise is eliminated.

Taken together with the mid-bass short horn and the 1505B HF horn there is about 8.5 square feet of radiating area in each A5. They image and energize a room much like a panel speaker but they have lower distortion, much better efficiency and dynamic capability. There is no troublesome back wave to contend with.

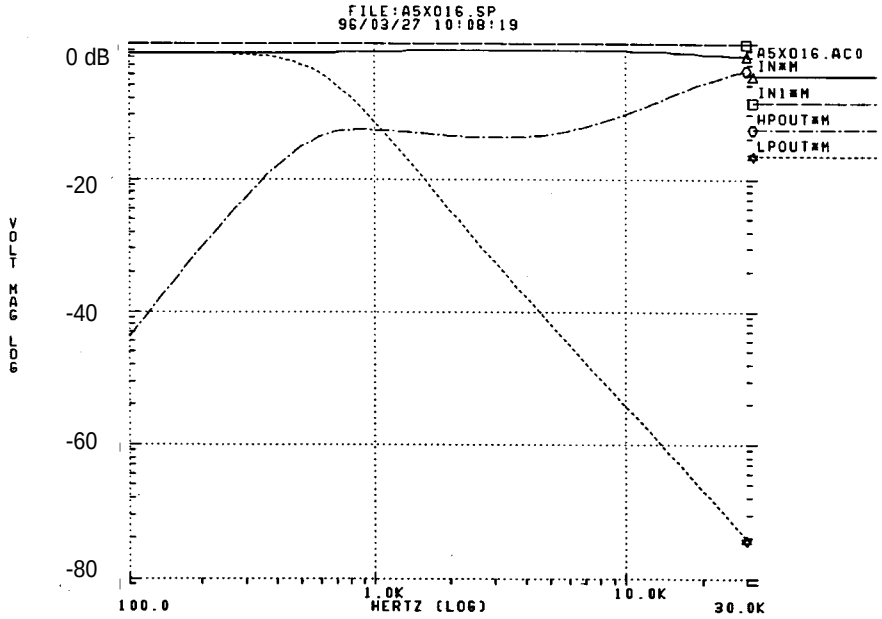
My recent vintage 828 cabinet is well constructed, although it is made of 5/8 inch compressed board. I will be augmenting this with 1/2 or 5/8 inch thick Apple ply, a high quality plywood with thick hardwood ply material. I am going to do this for cosmetic and acoustic reasons.

It has been suggested to inject the area behind the short horn flares with polyurethane insulation material. This sounds like a good idea and should stiffen and dampen the short horn. Although I haven't tried this yet, I don't find much to complain about in the performance that I am getting with the stock boxes.

Make sure that you have a thick bat of fiberglass or other acoustic material on the inside back wall of the enclosure to absorb the back wave at midrange frequencies, the driver is quite close to the back of the enclosure. Don't go overboard here as the low frequencies need to get out of the cabinet or the low frequency extension will be compromised.

If you are looking at older plywood cabinets beware of delamination of the plys as this can be impossible to rectify. Like ceramic magnets, compressed board may not be as sexy but it may be a better overall solution!

I have measured average levels at the listening seat of 100-103 dB when listening




**Response of LF, equalized HF driver, and summed response**

# STANDARD "VOICE OF THE THEATRE" COMPONENT CHART

| Model | Amplifier Power (Watts) | Distribution V° H° | L.F. Drivers | H.F. Drivers | H.F. Horn | Throat | Network | L.F. Cabinet | Overall Size — Inches H W D | Approx. Shipping Wt. Lbs. |
|---|---|---|---|---|---|---|---|---|---|---|
| A1X | 200 | 60 x 125<br>60 x 105<br>40 x 100 | (6) 515B | (4) 288C | 1804B<br>or 1504B<br>or 1004B | (2) 30170<br>(2) 30170<br>(2) 30170 | N500C | 610 | 113 x 152 x 39½<br>113 x 152 x 39½<br>105 x 152 x 39½ | 1530<br>1500<br>1475 |
| A1 | 100 | 60 x 105<br>40 x 100 | (6) 515B | (2) 288C | 1505B<br>or 1005B | (1) 30172<br>(1) 30170 | N500C | 610 | 108½ x 152 x 39½<br>102½ x 152 x 39½ | 1410<br>1390 |
| A2X | 150 | 60 x 105<br>40 x 100 | (4) 515B | (4) 288C | 1504B<br>or 1004B | (2) 30170<br>(2) 30170 | N500C | 410 | 113 x 113 x 39½<br>105 x 113 x 39½ | 1400<br>1334 |
| A2 | 80 | 60 x 105<br>40 x 100 | (4) 515B | (2) 288C | 1505B<br>or 1005B | (1) 30172<br>(1) 30170 | N500C | 410 | 108½ x 113 x 39½<br>102½ x 113 x 39½ | 1263<br>1250 |
| A4X | 60 | 60 x 105<br>40 x 100 | (2) 515B | (2) 288C | 1505B<br>or 1005B | (1) 30172<br>(1) 30170 | N500C | 210 | 108½ x 80½ x 39½<br>102½ x 80½ x 39½ | 788<br>775 |
| A4 | 40 | 60 x 105<br>40 x 100<br>40 x 80 | (2) 515B | (1) 288C | 1505B<br>or 1005B<br>or 805B | (1) 30166<br>(1) 30210<br>(1) 30162 | N500C | 210 | 108½ x 80½ x 39½<br>102½ x 80½ x 39½<br>102½ x 80½ x 39½ | 763<br>750<br>745 |
| A5X | 35 | 60 x 105<br>40 x 100<br>40 x 80 | (1) 515B | (1) 288C | 1505B<br>or 1005B<br>or 805B | (1) 30166<br>(1) 30210<br>(1) 30162 | N500C | 825B | 64 x 30½ x 30<br>59 x 30 x 27<br>59 x 30 x 27 | 393<br>280<br>275 |
| A7-8 | 50 | 40 x 90 | (1) 416-8A | (1) 807-8A | 811B | None | N801-8A | 825B | 52½ x 30 x 24 | 154 |
| A7-500-8 | 50 | 40 x 90 | (1) 416-8A | (1) 808-8A | 511B | None | N501-8A | 825B | 54½ x 30 x 24 | 160 |
| A8 | 30 | 60 x 90 | (1) 416A | (1) 806A | 30623 | None | N800D | 39624 | 42 x 30 x 12 | 112 |

to some recent Clapton (he sounds like he's fronting a great bar band...). At this level, with plenty of drum and bass energy and peaks of 110 to 115 dB, the 515 drivers are barely moving! This is a direct indication of the low distortion level that this system has under even extreme conditions. Most woofers would be moving up to 1/2 inch at these kinds of levels. This system is not even moving 1/8 inch peak to peak – well within the linear range of the driver.

Like the 1505B, the short horn in the 825/828 enclosure is inherently pleasing to look at and I would recommend leaving it open to the world. I suspect that a clear finish on light birch ply would complement the neutral gray of later 828 cabinets. I am going to make a simple hardwood foot assembly to support the 1505B and the 288 driver assembly. Typically they are mounted with 4 inch long L brackets and the adjustable rear support leg to a piece of 'vulgar' painted plywood, as my wife calls it. A more elegant T shaped construction with three cones for support would bring the 1505 somewhat lower and also provide some worthwhile mechanical isolation from bass cabinet energy.

### The crossover brings the system together...

If I did not have M. Hiraga's valuable input into the crossover design I would have been much more concerned about the outcome of this experiment. As it happens, his 10-20 years of experience with this type of system and his insight into how to knit the system together nearly guaranteed some level of success.

His original network shown above is for 8 ohm drivers. I scaled the values for the 16 ohm versions and added R5 to match levels. The complete crossover schematic is shown on p. 8.

I simulated the schematic using SPICE, a program that I use for Integrated Circuit (IC) design. It uses complex matrix equations to solve the nodal values for the circuit and is quite accurate if your model is accurate. The complete simulation schematic is provided on p. 8, including models I developed to simulate the non-linear impedances of the loaded drivers and I have added a 2.5 ohm resistor to simulate the output impedance of a typical SE triode amp driving this network.

L1 and C1 make up a 2nd order butterworth low pass network at 500 Hz for the 515 driver. It is quite simple and classic. For now I have a 500 watt rated ferrite core inductor with less than 0.5 ohm DCR and I used high power 660VAC rated oil filled polypropylene and paper capacitors for the low pass section (GE type 97F41XX). The idea is to be sure that the crossover components are stressed as little as the drivers in typical use.

The high frequency section is more complex with a basic high pass 2nd order section consisting of L2 and C2. I used an air core coil and 10 kHz rated low inductance, high power, oil filled caps for this section (GE type 97F85XX). R2 controls the maximum Q of the inductor and dampens transient overshoot energy, having little effect on the steady state frequency response. L3, and C3 along with R3, R4 and R5 make up a resonant trap with controlled Q and attenuation to equalize the 112 dB midband response of the 288 driver down to 100 dB and to allow it to go to 16 kHz with little attenuation.

The resulting response of this network into the simulated driver impedances is shown on page 9 above. Note that there is about 12 dB (over 4X voltage or 10X power) attenuation from 1-5 kHz with the response above and below this region allowed to rise as the natural rolloffs of the driver/horn take over. Again, L3 is an air core coil and C3 is a 19 kHz rated oil filled cap which are totally unstressed in this application.

The off the shelf cost of these components is more than a manufacturer would put in an entire $1500 pair of speakers, let alone a crossover network. I probably will replace L1 in the woofer circuit with a copper ribbon or some other exotic inductor as it is likely the limiting element in the implementation. All resistors are 50 watt rated wire wound aluminum cased units. You could give some range to R5 for a treble level control. I would suggest a 5 to 20 ohm range, this would give you several dB of adjustment without affecting the crossover frequencies. Use a good quality 20 watt single turn wire wound rheostat with a fixed resistor in series for an adjustable R5.

It is very instructive to listen to each driver alone through the crossover. Each frequency section sounds so very different that you wonder how the mushy low end and tinny high end can come together to make music. I believe that the 500 Hz crossover point is an ideal place for a crossover, as the Fletcher Munson curves show that the ear's operation changes at this point, acting differently above and below this frequency band. It seems a natural point to divide the spectrum. Listening tests bear this out.

**Phase align the Bass and Mid drivers...**

The separate 1505B horn allows you to move the upper frequency driver to align it with the bass and focus the energy toward your listening area. This is similar to what Wilson does with his larger systems and gives great flexibility in system setup and optimization.

I am using the speakers only about 8 inches from the back wall with the cabinets toed in so that the center is around 10-11 inches from the back and about 55 inches from the side walls. They image fine in this position and the Bestplace software available off the net from RDL Acoustics shows about 6-8 dB of room gain at 40 Hz. If used in a larger room, farther from room boundaries, you will need to add the wings to extend the last octave or so to get 40 Hz response. Putting them nearer to the back wall is great because it reduces the physical impact relative to smaller free standing speakers and the controlled directivity above 150 Hz means that imaging does not suffer at all. If they are too close to the back wall there will be too much mid bass energy.

I found that moving them only a few inches can make a real difference in how they load the room. My room is probably about as small as you would want to go with these and it is about 19 x 23 x 8 1/2 feet. This lets me put them 11 feet apart with a listening position 13-15 feet away. In this setup they have a remarkable ability to disappear acoustically and images can occur between, behind, and beyond them, as the recorded material allows.

When I align the HF horn I use a flashlight to make sure that I can see the diaphragm through the center horn from the listening chair. Then I move the horn forward and back relative to the bass driver while listening to a good female vocal to get the smoothest response through the crossover region. Movements as small as 1/8 inch can be audible.

**Why doesn't the stock crossover work in this type of speaker?**

That is really quite simple. For theater use the crossover is designed to be as lossless as possible, efficiency is everything when trying to fill a large space with intelligible speech and music.

| | 515 | 515B | 515C | 515E | 515-8LF | 515-8LFE | 515-8G | 515-16G | 515-8GH |
|---|---|---|---|---|---|---|---|---|---|
| Power | 35W | 75W | 75W | 75W | 125W | 125W | 75W | 75W | 200W |
| Response* | 55-1000Hz | 55-1000 | 55-1000 | 45-1000 | 45-1500 | 45-1000 | 50-4000 | 55-4000 | 60-4000 |
| X-over | 500 | 500 | 500 | 500 | 500 | 500 | 2,500 | 2,500 | 2,500 |
| Sens.** | | 105 dB | 105 dB | 105 dB | 105 dB | 105 dB | 105 dB | 106 dB | 106.5 dB |
| Z | 16 Ohms | 16 Ohms | 16 Ohms | 16 Ohms | 8 Ohms | 8 Ohms | 8 Ohms | 16 Ohms | 8 Ohms |
| Fs | 25Hz | 25Hz | 25Hz | 25Hz | 25Hz | 25Hz | 37Hz | 37Hz | 37Hz |
| Magnet | Alnico | Alnico | Alnico | Ferrite | Alnico | Ferrite | Ferrite | Ferrite | Ferrite |
| Flux | | 1.4750 T | 1.4750 T | 1.3T | 1.4750 T | 1.3T | 1.5T | 1.5T | 1.5T |
| Frame | 15" | 15"*** | 16" | 16" | 16" | 16" | 16" | 16" | 16" |

Notes: *Frequency response corrected to indicate 3dB down points for all models
**Sensitivity measurements corrected to 1W/1M rating
***515B manufactured after July 1977 had 16" frames

**Altec 515 LF Driver Revision History**

In a small room for music listening you need at least 12 dB of HF attenuation and you can let the higher harmonics come in better. These horns sound remarkably sweet in the upper frequencies and can even seem overly soft until some real HF energy comes in and startles you with its presence and detail. When EQed correctly, they have a very natural bloom and energy with very low distortion giving a sweet yet detailed sound.

Distortion of this speaker above 100 Hz at 100 dB out will be typically less than 0.05%! This level of distortion is even less than that provided by the 30 watt *Orfeo* amp which is around 0.07% at 1 watt out. I would guess that most people have never heard a loudspeaker with as low distortion as these. This contributes greatly to the naturally detailed sound and dynamics that approach those of live music.

**Upper frequency energy is very important to living, breathing music.**

Most (virtually all) dome tweeters are totally anemic in presenting upper frequency energy. They lack the bloom and subjective power that is needed to fill out the harmonic structures in music. They also tend to pinch the sound and lack dynamic headroom. The 288/1505B combination allows these frequencies to fill the room with ambiance and harmonic detail that otherwise I have only heard live.

**These speakers will not impress your friends with ultra low frequency energy and sensaround experiences.**

They will play a cello, timpani and string bass better than you have heard them before with tremendous midbass presence from the short horn and excellent, resonance free bass. If this can't impress your friends, get new ones! I hope that you can hear what a system like this can do. It's worth it.

### Addendum

I have just read a recent article in the *Journal of the Audio Engineering Society* (Vol. 44, No. 1/2, 1996 January/February) which throws some light on why the 1505B sounds so much better than other mid horns in my experience. This article titled 'The Sound of Midrange Horns for Studio Monitors' should be required reading. It describes a very well constructed test to compare the sound of midrange horns from 1kHz to 4kHz with several references. These references are the old QUAD electrostatic which is a long time reference for subjective midrange quality, an Audax (Polydax) 6 1/2 inch pro quality cone driver and two horn coupled mids including a large sectoral Fostex and a Tannoy. These references are compared to 14 different horn mids and a couple of cone control drivers. This article could be a model for scientifically valid subjective testing. Care was taken to choose test material and test methodology to avoid listener fatigue and stress and to insure valid results which correlate to listening to music. The authors' approach is much more sophisticated than the ABX method which some have tried to force on the industry.

Anyway, the results showed that there is a horn 'sound' with most mid horns. There were, however, two horns which were never identified as being horns in the blind testing. One is a prototype short horn with a medium mouth opening and a length of only 230mm. The other horn is an old ALTEC 806C 8 cell multicell which is a smaller version of the 1505B with the same basic construction and fewer individual cells.

There are two keys to these horns' performance. The short horn length on the one means that any mouth reflections occur in a short time span and are subjectively innocuous. On the long ALTEC horn the mouth area is large enough, compared to the cutoff frequency, that the mouth reflections are a small fraction of a dB.

The second key to the subjective sound quality is that these horns are designed to have no abrupt flare rate changes along their lengths from the phase plug to the mouth opening. Any flare rate discontinuity causes high frequency reflections which cause spectral colorations and problems in the upper mids and high frequencies. Neither of these horns have flare rate discontinuities when used with the right compression drivers.

Indeed, the ALTEC multicell horn was thought to sound most like the QUAD electrostat. It was not identified as a horn speaker by any of the listeners, including a 'Golden Eared' pro who was among the test subjects. It seems that this old design was very well thought out when it was done originally for cinema use in the 30s and 40s.

I also suggest that you seek out Harry F. Olson's 1947 book *Elements of Acoustical Engineering*. Page 106, section 5.24 has an excellent discussion of the mouth reflection effects of a horn and shows clearly why a large mouthed long horn will sound better, avoiding the 'horn' sound problem that shows up with many small midrange horns. The solution to mid horn sound problems was clearly known back then, they knew more than we have forgotten.

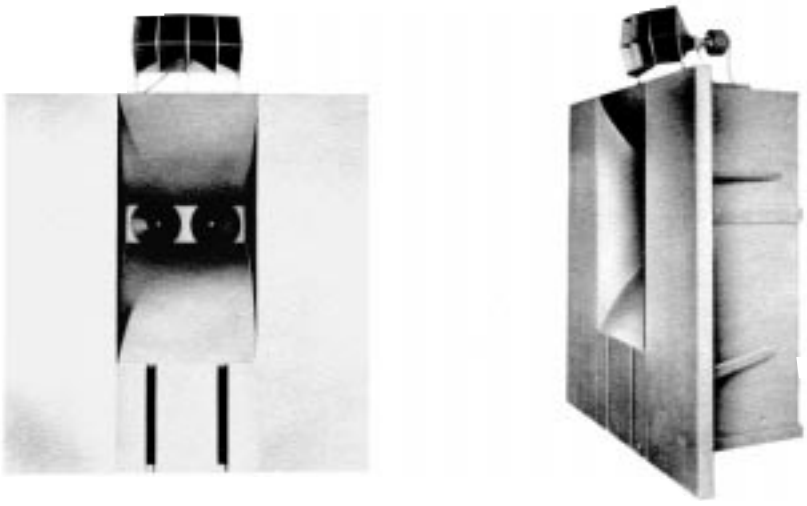
Special thanks to Jean Hiraga for sharing his research with the audio community.

Thanks also to Jim Long and Gary Jones of the Mark IV Audio North America pro sound team.

Altec info reprinted by permission of Mark IV North America.

# Low Frequency Horns

L-F HORNS



210 Horn with speakers installed

## Features

- Direct Radiating
- Rugged Construction
- Authentic Bass Reproduction
- Exponential Expansion
- Wide Distribution
- Exceptional Air Coupling
- Uniform Response
- Variety of Sizes
- Efficient Bass Projection

**For High Quality, Two-Way Sound Systems In . . .**
**Theatres • Auditoriums • Arenas • Churches**
**Concert Halls • Audition Rooms**

Altec "Voice Of The Theatre" speaker systems are used in more than 12,000 motion picture theatres, auditoriums, arenas and other sound reinforcement installations throughout the world. An important component of each such system is an Altec Low Frequency Horn.

These large low frequency horns ensure proper loading which effects excellent air coupling and enhances the performance of the low frequency loudspeakers. Exponential expansion, properly spatial phased with the high frequency horn, assists the projection of the important mid-range frequencies.

Front loaded in design, Altec Low Frequency Horns have no folds or bends to introduce 'holes' or 'hot spots' in the sound coverage. The elimination of any irregularities assures a uniform response across the dispersion angle of the horn, a factor essential in the calculation of sound systems. The combination bass reflex/front loaded design prevents the boom and false accentuation often associated with public address systems which use other types of enclosures, reduces the amplitude of cone movement at resonant frequencies, and allows higher power input without distortion. The efficient use of the lower end of the sound spectrum contributes to the illusion of loudness and presence required to distinguish the outstanding Altec "Voice Of The Theatre" system from ordinary loudspeaker systems. For installations where the 210 and 410 horns are used on the floor, the use of wings will further improve the bass projection.

Altec Low Frequency Horns are carefully constructed with heavy materials and braced where acoustically required to exclude unwanted vibrations. The sturdiness of these horns permit them to be mounted in walls and ceilings of auditoriums, or to be suspended overhead in large areas. All horns are finished with a flat finish, dark grey, instrument lacquer. Where the horns are to be used in outdoor installations, a weatherproof coating of resin may be applied without impairment of their performance.

These horns are designed for use with either the Altec 416A or 515B Low Frequency loudspeakers. They should be used in conjunction with high frequency horns (multicellular or sectoral) and high frequency drivers for a full range, two-way system (see Table III).

ALTEC LANSING

*A Division of* LING-ALTEC *Ling Altec, Inc.*

**1515 S. Manchester Ave., Anaheim, Calif.**
**New York**

# ALTEC L-F HORNS

**TABLE I: SPECIFICATIONS**

| Horn Model Number (A) | Number of Low Frequency Speakers Per Horn (B) | DIMENSIONS (C) | | | | Weight (Without Wings) (D) |
|---|---|---|---|---|---|---|
| | | Height | Width | | Depth | |
| | | | With Wings | Without Wings | | |
| 210 | 2 | 84" | 80½" | 32½" | 39½" | 560 lbs. |
| 211* | 2 | 32½" | (Not Used) | 84" | 39½" | 560 lbs. |
| 410 | 4 | 84" | 103" | 65" | 39½" | 890 lbs. |
| 825 | 1 | 42" | (Not Used) | 30" | 24" | 100 lbs. |

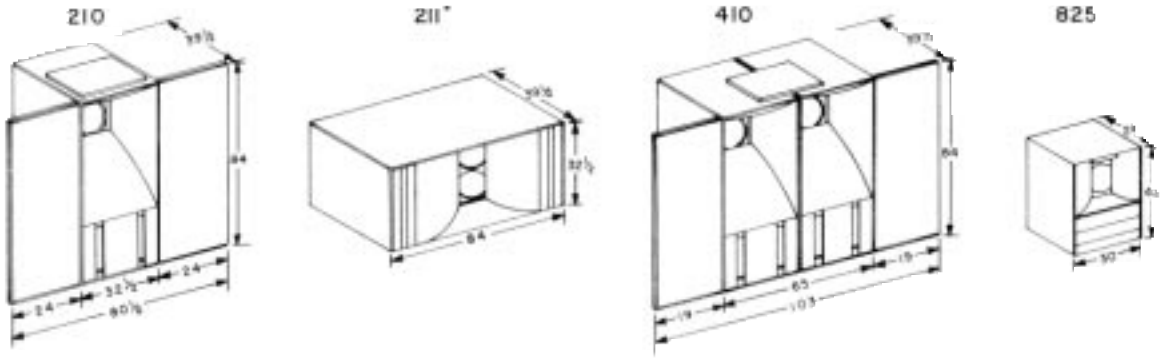



FIGURE 1: Dimensional Drawings of Altec Low Frequency Horns.
*Available on special order only

**TABLE II: Recommended Components for Complete Systems**

| LF Horn | Power (Watts) | HF Drivers | LF Drivers | HF Horn No. | Distribution | Throat | Network (16 ohm) | Overall Size H W D | Approx. Shipping Weight |
|---|---|---|---|---|---|---|---|---|---|
| 410 | 150 | 4 — 288C | 4 — 515B | 1804B,<br>1504B,<br>1004B | 60° x 125°<br>60° x 105°<br>40° x 100° | 2-30170<br>2-30170<br>2-30170 | N500C | 113" x 120" x 39½"<br>113" x 120" x 39½"<br>105" x 120" x 39½" | 1400 |
| 410 | 80 | 2 — 288C | 4 — 515B | 1505B,<br>1005B | 60° x 105°<br>40° x 100° | 1-30172<br>1-30170 | N500C | 108½" x 120" x 39½"<br>102½" x 120" x 39½" | 1250 |
| 210 | 60 | 2 — 288C | 2 — 515B | 1505B,<br>1005B | 60° x 105°<br>40° x 100° | 1-30172<br>1-30170 | N500C | 108½" x 80½" x 39½"<br>102½" x 80½" x 39½" | 775 |
| 210 | 40 | 1 — 288C | 2 — 515B | 1505B,<br>1005B,<br>805B | 60° x 105°<br>40° x 100°<br>40° x 80° | 1-30166<br>1-30210<br>1-30162 | N500C | 108½" x 80½" x 39½"<br>102½" x 80½" x 39½"<br>102½" x 80½" x 39½" | 750 |
| 825 | 35 | 1 — 288C | 1 — 515B | 1505B,<br>1005B,<br>805B | 60° x 105°<br>40° x 100°<br>40° x 80° | 1-30166<br>1-30210<br>1-30162 | N500C | 64" x 30½" x 30"<br>59" x 30" x 27"<br>59" x 30" x 27" | 275 |
| 825 | 30 | 1 — 806A | 1 — 416A | 811B | 40° x 90° | None | N800D | 54" x 30" x 24" | 200 |
| 825 | 30 | 1 — 806A | 1 — 416A | 511B | 40° x 90° | None | N500E | 54" x 30" x 24" | 200 |

**NOTICE**

*We recommend that you obtain your Altec products from factory trained authorized Altec Sound Contractors and Distributors. They will assure you of proper installation, a continuing source of knowledgeable advice, service, and quick warranty protection.*

**ARCHITECTS AND ENGINEERS SPECIFICATIONS**

The low frequency horn shall be of the direct radiating type with an enclosure of combined bass reflex/front loaded type. It shall consist of a short exponential horn designed to match the phasing of the high frequency horn specified elsewhere. Horns which employ folds or bends will not be acceptable under this specification because of their tendency toward frequency cancellation.

The horn shall measure (C) and weigh approximately (D). It shall be of heavy plywood and shall be fully braced with 2" x 3", and 2" x 4" frames. It shall be designed to mount and properly load (B) low frequency speakers of the type specified elsewhere.

Any low frequency horn not meeting these requirements shall not be acceptable under this specification.

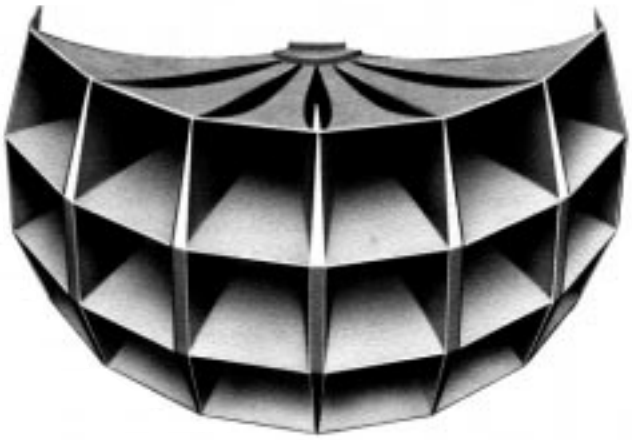
The low frequency horn shall be Altec Lansing Model (A).

Litho in USA C/P 3/66

AL-1435-1

# Multicellular Horns





**AUDITORIUMS • STADIUMS • ARENAS • THEATRES • AIRPORT TERMINALS**
**OUTDOOR VOICE WARNING SYSTEMS • INDUSTRIAL AND COMMERCIAL INSTALLATIONS**

The exponential multicellular horn is the most efficient of all projectors for delivering top quality sound uniformly over a defined listening area. The unique excellence of the multicellular horn results from its distinctive design:

(a) The multicellular horn consists of a number of individual horns assembled in various configurations to provide controlled angles of vertical and horizontal distribution for best sound coverage of any listening area.

(b) Each horn or cell of the multicellular horn is a straight exponential trumpet through which sound can pass unimpeded. This is a distinct advantage over horns of the re-entrant or reflex type which severely attenuate the high frequencies and cause distortion due to sharp folds or bends in the sound passage.

(c) The column speaker exercises control of sound only in the vertical plane, whereas the multicellular horn controls sound in both the vertical and horizontal planes thus providing the added advantage of restricting sound projection into reverberant side walls.

(d) The re-entrant or reflex horn and the column speaker are handicapped by the fact that the beam width becomes steadily narrower as frequency increases, to a point where sound coverage in the critical high frequency range between 2,000 and 10,000 cycles shrinks to a narrow pencil of sound, in some cases only 15° to 30° wide.
In contrast, the beam width of the multicellular horn above the cross-over region and in the important mid- and high-frequency regions to 12,000 cycles and beyond, is independent of frequency. This entire portion of the frequency spectrum is uniformly distributed throughout the full angle of the horn.

(e) The multicellular horn with its great undistorted power handling capacity (up to 400 watts) is unequaled by any other commercially available sound projector for distribution of highest quality sound over large outdoor areas.

Altec multicellular horns will accommodate as many as four drivers of the 288C type for indoor use, or 730B and 290D type for outdoor use. The latter drivers and the 30546 angle adaptor in combination with a multicell horn constitutes a complete All-Weather system.

The multicellular horn was developed by the Bell Telephone Laboratories of a necessity to insure the success of early talking pictures. Ordinary horns proved incapable of providing good quality coverage to every seat in large theatres, most of which were far from ideal acoustically. The folded horn was discarded in theatre work in 1934 and since that time the multicellular horn has remained the standard of excellence.

The 300 cycle cutoff multicellular horn is often used as a "one-way" speaker where voice only is to be reproduced, or where maximum intelligibility is required to penetrate high ambient noise levels, or for projection over long outdoor distances. The 500 cycle multicellular horn with a 500 cycle crossover network and low frequency speakers, Altec 416A or 515B, are generally used for full range "two-way" loudspeaker systems such as Altec "Voice of the Theatre" systems for the reproduction of high quality voice and music.

PERFORMANCE AND SPECIFICATION DATA ON BACK PAGE

ALTEC LANSING

A Division of [illegible] Ling Altec, Inc.

1515 S. Manchester Ave., Anaheim, Calif.
New York

# MULTICELLULAR HORN PERFORMANCE CHART

| Horn Model Number* (a) | Quantity of Drivers Used per Horn (b) | Driver Model Number (c) | Sound Pressure Level Full Power Each Driver** Measured at 30 feet (d) | Sound Pressure Level Full Power Each Driver** Measured at 100 feet (d) | Distribution Pattern (e) | Cutoff Frequency (f) | Cell Configuration | Throat Code Number *** |
|---|---|---|---|---|---|---|---|---|
| 2038 | 1 | 288C | 118 db | 108 db | 20° x 40° | 300 cps | 1 x 2 | (not required) |
| | | 290D | 121 db | 111 db | | | | |
| | | 730B | 114 db | 104 db | | | | |
| 8038 | 1 | 288C | 115 db | 105 db | 35° x 70° | 300 cps | 2 x 4 | 30162 |
| | | 290D | 118 db | 108 db | | | | |
| | | 730B | 111 db | 101 db | | | | |
| 8048 | 2 | 288C | 118 db | 108 db | 35° x 70° | 400 cps | 2 x 4 | 30172 |
| | | 290D | 121 db | 111 db | | | | |
| | | 730B | 114 db | 104 db | | | | |
| 8058 | 1 | 288C | 113 db | 103 db | 40° x 80° | 500 cps | 2 x 4 | 30162 |
| | | 290D | 116 db | 106 db | | | | |
| | | 730B | 109 db | 99 db | | | | |
| 10038 | 1 | 288C | 113 db | 103 db | 35° x 90° | 300 cps | 2 x 5 | 30210 |
| | | 290D | 116 db | 106 db | | | | |
| | | 730B | 109 db | 99 db | | | | |
| 10038 | 2 | 288C | 116 db | 106 db | 35° x 90° | 300 cps | 2 x 5 | 30170 |
| | | 290D | 119 db | 109 db | | | | |
| | | 730B | 112 db | 102 db | | | | |
| 10048 | 4 | 288C | 119 db | 109 db | 40° x 100° | 400 cps | 2 x 5 | (2) 30170**** |
| | | 290D | 122 db | 112 db | | | | |
| | | 730B | 115 db | 105 db | | | | |
| 10058 | 1 | 288C | 112 db | 102 db | 40° x 100° | 500 cps | 2 x 5 | 30210 |
| | | 290D | 115 db | 105 db | | | | |
| | | 730B | 108 db | 98 db | | | | |
| 10058 | 2 | 288C | 115 db | 105 db | 40° x 100° | 500 cps | 2 x 5 | 30170 |
| | | 290D | 118 db | 108 db | | | | |
| | | 730B | 111 db | 101 db | | | | |
| 15048 | 4 | 288C | 118 db | 108 db | 60° x 105° | 400 cps | 3 x 5 | (2) 30170**** |
| | | 290D | 121 db | 111 db | | | | |
| | | 730B | 114 db | 104 db | | | | |
| 15058 | 1 | 288C | 110 db | 100 db | 60° x 105° | 500 cps | 3 x 5 | 30166 |
| | | 290D | 113 db | 103 db | | | | |
| | | 730B | 106 db | 96 db | | | | |
| 15058 | 2 | 288C | 113 db | 103 db | 60° x 105° | 500 cps | 3 x 5 | 30172 |
| | | 290D | 116 db | 106 db | | | | |
| | | 730B | 109 db | 99 db | | | | |
| 18038 | 1 | 288C | 110 db | 100 db | 53° x 105° | 300 cps | 3 x 6 | 30166 |
| | | 290D | 113 db | 103 db | | | | |
| | | 703B | 106 db | 96 db | | | | |
| 18038 | 2 | 288C | 113 db | 103 db | 53° x 105° | 300 cps | 3 x 6 | 30172 |
| | | 290D | 116 db | 106 db | | | | |
| | | 730B | 109 db | 99 db | | | | |
| 18048 | 4 | 288C | 116 db | 106 db | 60° x 125° | 400 cps | 3 x 6 | (2) 30170**** |
| | | 290D | 119 db | 109 db | | | | |
| | | 730B | 112 db | 102 db | | | | |

* Model code denotes number of cells and horn cutoff frequency. Example: 15048 — a 15 cell horn (3 rows of 5 cells per row) with cutoff frequency of 400 cps.

** Sound Pressure Level (SPL) as shown in column (d) above is based or measured at 30 and 100 feet with full rated power applied to each driver as shown in column (b) and averaged uniformly over 600 to 2,400 cps. (see note 1.)

*** One 30474 Adapter required in addition to indicated throat for each 730B Driver used.

**** If only two drivers are desired on the 400-cycle horn, use two 30210 single throats in place of two 30170 double throats.

NOTE 1. Full power rating on
288C is 40 watts
290D is 100 watts
730B is 60 watts

NOTE 2. Driver units should be protected against low frequency by use of N500C Altec Network, or the 15045A Line Transformer.

NOTE 3. It is recommended that 30546 45-degree angle adapters be added to each driver for added weather protection in all outdoor installations.

NOTE 4. Sound Pressure Level Conversion Table

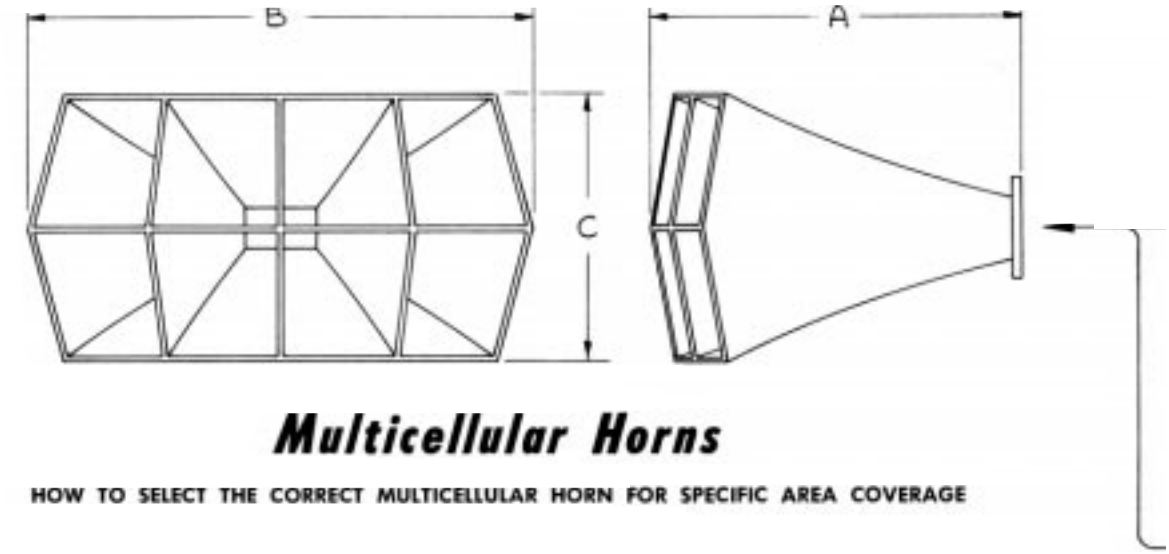
I) To increase SPL 3 db double the input power; to increase 6 db, quadruple the input power.

II) Each time distance of horn projection is doubled substract 6 db SPL.

## ARCHITECTS AND ENGINEERS SPECIFICATIONS

The high-frequency horn shall be of the multicellular type, equipped with proper throat and adapters and (b) (c) compression driver or transducer. As specified elsewhere, it shall produce a uniform sound pressure field of (d) db at a distance of (select from d) feet with (Note 1) watts input power applied to each driver over a field of distribution of (e) uniformly averaged over the band of 600 to 2,400 cps. Single frequency measurements will not be acceptable under this specification. The low-frequency cutoff shall be (f) cps.

The horn shall be constructed of individual weatherproofed metal cells with a special damping material coating the external surfaces of each cell. The cells shall all be straight with an exponential expansion. Folded or re-entrant horns or horns fabricated of wood or other fiberous materials will not be acceptable. The horn shall be equipped with mounting brackets or facilities both on the front or mouth and on the appropriate cast throat. Multicellular horn shall be Altec Lansing Model (a).
(Note: Fill in proper values and numbers from Horn Performance Chart.)




# Multicellular Horns

## HOW TO SELECT THE CORRECT MULTICELLULAR HORN FOR SPECIFIC AREA COVERAGE

Multicellular projectors are available in several configurations. The sound distribution pattern (angle) is determined by the cell arrangement. Each cell of a 500 cycle horn projects sound over an area of 20° square, or 400 square degrees per cell; a 400 cycle horn distributes sound over an area of 19° square per cell and a 300 cycle horn over an area of 17-1/2° square per cell (2038 horn - 20° square per cell). The sound distribution pattern, both horizontal and vertical, of a horn, is established by the total number of cells assembled in each plane.

Determine the area to be covered and, by reference to the chart on page 4 of this bulletin, select the horn having a distribution pattern which will most closely cover this area. To obtain full advantage of controlled distribution, no greater area of sound coverage should be provided than can be effectively used. Multicellular horns are composed of a group or stack of individual horns so that each small horn becomes a component part of the large horn assembly. All cells are fed from a common throat.

The partial spherical front achieved by grouping the cells allows each cell to contribute to the whole without overlap or confusion. In installations where speech only is to be projected, the projection ability of a 300 cycle horn can be increased by sharply cutting off the low frequency energy fed the horn an octave above the rated cutoff of the horn by use of an Altec N-500C network or the 15045A 70-volt line transformer. In this manner, the horn has an effective length considerably greater than its physical length. By selection of the proper cell configuration, the projected sound is fully controlled in both the vertical and horizontal plane and this feature proves useful in combating high reverberation and in minimizing or eliminating acoustic feedback. A 300 cycle horn in combination with a 500 cycle crossover network, will greatly aid in overcoming objectionable reverberation by giving the horn greater projection ability by restricting the radiation of the low frequencies, which are often undesirable in the masking of sound and contribute little or nothing to speech intelligibility.

## Accessories

N-500C Dividing Network Set

15045A 70-Volt Line Transformer

30546 45° weatherproof throat adapter

30162 horn throat (single unit)

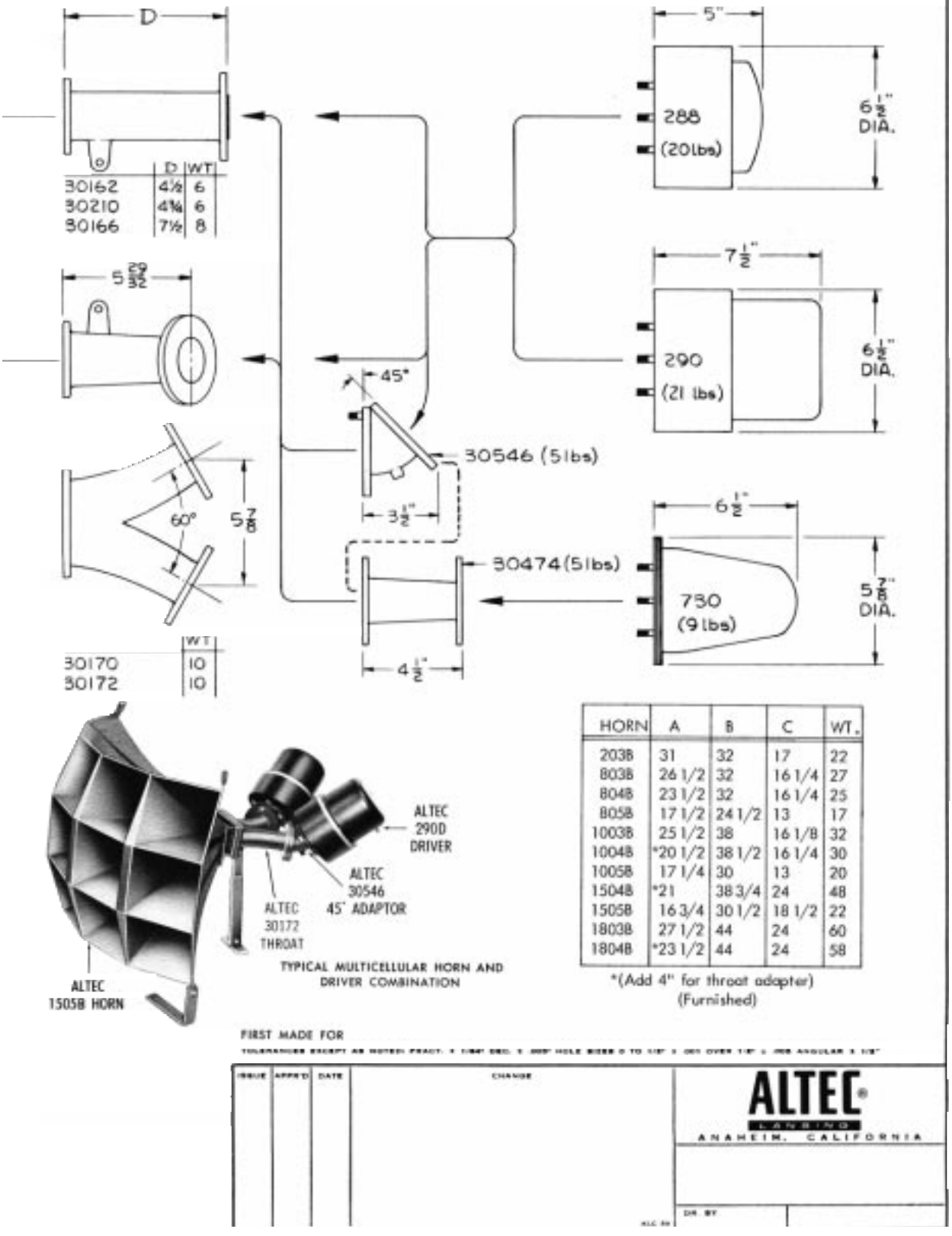
30210 horn throat (single unit)

30166 horn throat (single unit)

30170 horn throat (double unit)

30172 horn throat (double unit)

30474 adapter




| HORN | A | B | C | WT. |
|---|---|---|---|---|
| 203B | 31 | 32 | 17 | 22 |
| 803B | 26 1/2 | 32 | 16 1/4 | 27 |
| 804B | 23 1/2 | 32 | 16 1/4 | 25 |
| 805B | 17 1/2 | 24 1/2 | 13 | 17 |
| 1003B | 25 1/2 | 38 | 16 1/8 | 32 |
| 1004B | *20 1/2 | 38 1/2 | 16 1/4 | 30 |
| 1005B | 17 1/4 | 30 | 13 | 20 |
| 1504B | *21 | 38 3/4 | 24 | 48 |
| 1505B | 16 3/4 | 30 1/2 | 18 1/2 | 22 |
| 1803B | 27 1/2 | 44 | 24 | 60 |
| 1804B | *23 1/2 | 44 | 24 | 58 |

*(Add 4" for throat adapter)
(Furnished)

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