UTILITIES, TABLES AND GENERAL INFORMATION

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

CATEGORIES:
- 2100 - Midrange and mid-bass cone transducers
- 2200 - Low frequency transducers (woofers)
- 2300 - Horns and horn throat adapters
- 2400 - Compression drivers
- 2500 - Mounting brackets
- 3100 - Passive Crossover networks
- 4300 - Older studio monitors (enclosed systems)
- 4400 - Newer monitors and Bi-Radial monitors
- 4500 - Low frequency enclosures - unloaded
- 4600 - Theater, Cabaret & loaded low frequency enclosures
- 4700 - European Sound Power Speakers Systems and accessories
- 4800 - Concert Series loudspeaker systems
- 4900 - Concert Series complete packaged systems
- 5000 - Crossovers, Mixers, Equalizers
- 6200 - Amplifiers (high-level electronics)
- 6800 - Video Products
- 7000 - Special purpose electronics (7510B, 7110)
- 8000 - Industrial series stamped frame loudspeakers
- GXXX - G-series or Performance Series systems
- E, G, MI, - Musical instrument loudspeakers
- MTC - Control Series mounting hardware(See 2500 series info)

2100 SERIES: CONE TRANSDUCERS

LE8T-H - 8" 40 watt full range transducer
2105H - 5" mid 40 W, similar to 5" in 4311, 4411 monitors
2108 - 8" mid, 75 W, 3" voice coil, used only in 4315B (Obsolete)
2110 - 8" extended range 20 W, (Obsolete)
2115H,J - 8" full range transducer lighter cone LE8 (Obsolete)
2118H,J - 8" mid 200 W, used in Cabaret Series 4612B, 4628B
2120 - 10" extended range 60 W, old pro version of D110 (Obsolete)
2121H - 10" mid 75 W, used in 4343, 4344, 4345 monitors (Obsolete)
2123H,J - 10" mid 250 W, (new 10-85)
2130 - 12" old pro version of D120 (Obsolete)
2135 - 15" old pro version of D130 (Obsolete)
2145 - 12" coax composite transducer with 1" HF (Obsolete)
2150 - 15" coax composite transducer with 5" HF (Obsolete)

2200 SERIES: CONE TRANSDUCERS

2202H - 12" midrange/midbass 300 W, used in 4350, 4355 monitors
2203H - 12" low bass 100 W, used in 4315 studio monitor (Obsolete)
2204H,J - 12" high-power bass similar to 2225H (new 10-85)
2205H,J - 15" predecessor of 2225H (Obsolete)
2215H - 15" low bass used in UREI 813C (order from UREI as replacement)
2220H,J - 15" high-efficiency woofer/midbass 200 W
2225H,J - 15" high power bass, 400 W, used in theater system enclosures
2230 - 15" white Aquaplas cone 15" woofer used in old 4350 (Obsolete)
2231A - 15" low bass 100 W, used in 4331, 4333, 4341, 4343 monitors
2231H - 15" predecessor of 2235H (both 2231A, H (Obsolete)
2234H - 15" mid-efficiency bass 150 W, two used only in 4435 monitor
2235H - 15" low bass 150 W, used in 4430 monitor, B380 subwoofer
2240G,H - 18" high-power bass 600 W
2245H - 18" subwoofer 600 W, used in 4645, 4845, B460
2290 - pro version passive 15" radiator (Obsolete)

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

2300 SERIES: HORNS, LENSES & ADAPTERS

2301 - "potato-masher" round perforated plate lens for 1" drivers (Obsolete)
2307 - round exponential for 1" throat (Obsolete)
2308 - lens for 2307, 2311, 2312 (Obsolete)
2311 - short round exponential for 2" throat (Obsolete)
2312 - long round exponential for 1" throat (Obsolete)
2327 - throat adapter for 2425 to 2" horns (2360-86)
2328 - throat adapter for 2" to large radials (2350-55-56) (Obsolete)
2329 - twin throat adapter for 2 x 2" to large radials (Obsolete)
2330 - throat adapter 1.4" (Altec) driver to 2" JBL horns (Obsolete)
2340 - small bent radial for 1" drivers (Obsolete)
2342 - screw-throat bi-radial used in 4425 monitor
2343 - exponential oval for 2" throat (Obsolete)
2344 - 12.5" square Bi-Radial used in 4430 monitor, 1" throat
2345 - 1" throat one-piece cast aluminum radial (Obsolete)
2346 - 1" throat Defined Coverage horn used in 4660
2350 - 2" throat large cast aluminum 90 X 40 radial (Obsolete)
2355 - 2" throat large cast aluminum 60 X 40 radial (Obsolete)
2356 - 2" throat large fiberglass 40 X 20 radial (Obsolete)
2360A - Large 2" throat 90 X 40 deg. Bi-Radial horn
2365A - Large 2" throat 60 X 40 deg. Bi-Radial horn
2366A - Large 2" throat 40 X 20 deg. Bi-Radial horn
2370A - Smaller 1" throat, flat-front 90 X 40 deg. Bi-Radial horn
2371 - 1" screw-throat, flat-front 90 X 40 deg. used in G series
2380A - Smaller 2" throat, flat-front 90 X 40 deg. Bi-Radial horn
2382A - Smaller 2" throat, flat-front 120 X 40 deg. Bi-Radial horn
2385A - Smaller 2" throat, flat-front 60 X 40 deg. Bi-Radial horn
2386 - Smaller 2" throat, flat-front 40 X 20 deg. Bi-Radial horn
2390 - 2" serpentine lens horn for 2" driver (Obsolete)
2395 - 36" slant plate horn/lens for 2445J (Obsolete)
2397 - "Smith horn" - wood construction diffraction horn (Obsolete)

2400 SERIES: COMPRESSION DRIVERS

2402H - ring radiator tweeter (JBL "Bullet") Note 1
2403H - oval horn tweeter (Obsolete)
2404H - Bi-Radial 100 X 100 deg. tweeter (SALES MODEL) Note 2
2404H-1 - used in Cabaret models 4612B, 4628B, and 4698B Note 1
2405H - diffraction slot tweeter Note 2
2410 - 1" throat, aluminum diaphragm comp. driver (Obsolete) *
2420 - 1" throat, aluminum diaphragm comp. driver (Obsolete) *
2421 - as above, used in older 4430, 4435 monitors *
2426H,J - 1" throat, titanium diaphragm comp. driver (Obsolete) *
2426H,J - 1" throat, titanium diaphragm comp. driver
2427H,J - 2" throat version of 2426 type driver (late 1987)
2440 - 2" throat, aluminum diaphragm comp. driver (Obsolete) *
2441 - 2" throat, aluminum diaphragm comp. driver *
2445J - 2" throat, titanium diaphragm comp. driver
2450J - 2" neodymium magnet/titanium diaph. comp. driver (Available 5-88)
2460 - 1" throat, phenolic diaphragm comp. driver (Obsolete) *
2461 - 1" throat, phenolic diaphragm comp. driver (Obsolete) *
2470 - 1" throat, phenolic diaphragm comp. driver (Obsolete) *
2482 - 2" throat, phenolic diaphragm comp. driver (Obsolete '86)
2485J - 2" throat, phenolic diaphragm comp. driver (replaces 2482)
375AB - fog horn driver - contact JBL for information.
375EX - explosion-proof driver - contact JBL for information.

Notes: * - new titanium diaphragm assemblies retrofit these models.
1 - models use 0.0015" replacement diaphragm model D8R075
2 - models use 0.0010" replacement diaphragm model D16R2405
(3105 crossover provides correct frequency with both models.)

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

2500 SERIES: MOUNTING HARDWARE, STANDS, ACCESSORIES

100WA-BC - Omnimount Wall bracket for 8330 (10 ea per master pack)
2504 - Driver mounting "L" bracket for 2402 and 2405
2506 - Mounting bracket for 2360 and 2365 horns (theater systems)(OBSOLETE)
2506A - Mounting bracket for 2360 and 2365 horns (theater systems)
2507 - 3-way adjustable bracket for 1" throat horns
2508 - Mounting "L" bracket for 2380 series horns
2509 - 3-way adjustable bracket for 2" throat horns
MA15 - Mounting clamp kit for woofers
MC4401 - Mounting cradle for 4401 studio monitor
MT4612 - Tripod stand for 4612B, 4825, G-730, G-733, G-734
MTC-1 - Camera tripod mounting adapter for Control 1 (12ea per master pak)
MTC-2 - Ceiling wall-mount, ball joint bracket for Control 1 (12 ea per master pak
MTC-2-MG - Medium grey ceiling/wall-mount bracket for Control 1
MTC-2-WH - White ceiling/wall-mount bracket for Control 1
MTC-3 - Clamp mounting system Control 1
MTC-4 - European mic stand adapter for use with MTC-1 (20 ea per master pak)
MTC-5 - American 3/4" mic stand adapter for use with MTC-1 (20 ea per master pak)
MTC-6 - Japanese mic stand adapter for use with MTC-1 (20 ea per master pak)
MTC-7 - Includes and MTC-5 and MTC-1 (12 ea per master pak)
MTC-8 - Ceiling/wall-mount "L" bracket for Control 1 (10 ea per master pak)
MTC-51 - Wall-mount, ball joint bracket for Control 5 (6 ea per master pak)
MTC-52 - Ceiling-mount, ball joint bracket for Control 5 (6 ea per master pak)
MTC-53 - Rack mount bracket fits 19" EIA standard rack for Control 5 (4 ea per mast
MTC-54 - Control 5/MT4612 tripod mounting adapter (6 ea per master pak)
MTC-56 - Wall-mount, low cost, slide mount bracket for Control 5
MTC-101 - Universal mounting adapter for Control 10/12SR/MT4612
MTC-102 - Wall-mount
MTC-103 - Ceiling-mount
MTC-104 - Home floor stand
MTC-105 - Mounting Yoke
MTC 106 - Coth cover

3100 SERIES: PASSIVE FREQUENCY DIVIDING NETWORKS

3101A power pack crossover - 1500 Hz (Obsolete) (use 3120A)
3102 power pack crossover - 3000 Hz (Obsolete) (use 3105)
3104 power pack crossover - 3000 Hz (Obsolete) (use 3105)
3105 - 7000 Hz, 70 W, for 2426J or 2445J and 2402H, 2404H, or 2405H
3110A - 800 Hz, 300 W, with power response correction for Bi-Radial horns
3115A - 500 Hz, 300 W, with power response correction for Bi-Radial horns
3120A - 1250 Hz, 300 W, with power response correction for Bi-Radial horns
3160 - 500 Hz, 600 W, with power response correction for Bi-Radial horns

4300 SERIES: CONTROL MONITORS

4312A L,R - three-way system, 12" woofer, 5" mid, titanium dome tweeter
CONTROL-1 - miniature two-way loudspeaker system, molded enclosure
CONTROL-1MG - medium gray, miniature two-way loudspeaker system, molded enclosure
CONTROL-1SLVR - silver, miniature two-way loudspeaker system, molded enclosure
CONTROL-1WH - white, miniature two-way loudspeaker system, molded enclosure
CONTROL-5 - small two-way loudspeaker system, molded enclosure
CONTROL-5GY - gray, small two-way loudspeaker system, molded enclosure
CONTROL-5MG - medium gray, small two-way loudspeaker system, molded enclosure
CONTROL-5WH - white, small two-way loudspeaker system, molded enclosure
CONTROL-10 - 12" 3-way loudspeaker system, molded enclosure
CONTROL-12 SR - 2-way molded enclosure loudspeaker system w/G-125B-8,2416H, 2372
SLT-1 - miniature two-way loudspeaker system, die-cast aluminum enclosure

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

4400 SERIES: STUDIO MONITORS

4406 - two-way system, 6.5" woofer, titanium dome tweeter
4408 - two-way system, 8" woofer, titanium dome tweeter
4410L,R - three-way system, 10" woofer, 5" mid, titanium dome tweeter
4412L,R - three-way system, 12" woofer, 5" mid, titanium dome tweeter
4425L,R - two-way system, 12" woofer, Bi-Radial horn
4430L,R - two-way system, 15" woofer, Bi-Radial horn
4435L,R - two-way system, dual 15" woofers, Bi-Radial horn

4500 SERIES: UNLOADED LOW FREQUENCY ENCLOSURES

4507 - 5 cubic foot vented box for single 15" driver tuned to 40 Hz
4508 - 8 cu ft vented box for double 15" drivers tuned 40 Hz
4512 - 1.2 cu ft vented box for single 12" driver tuned 50 Hz
4518 - 8 cu ft vented subwoofer box for single 18" driver tuned 30 Hz
4550BKA - Dual 15" transducer, front loading horn, utility black, limited availabilit
4560BKA - Single 15" transducer, front loading horn, utility black, limited availabil
4520 - Rear loading, vented,dual 15" transducer folded horn Obsolete
4530 - Rear loading, vented, single 15" transducer folded horn Obsolete

CABARET SERIES LOUDSPEAKER SYSTEMS:

4602B - small wedge stage monitor, E120-8, 2402H
4604B - small stand-mount vocal system, (2) 2118J, 2404H-1*
4622M - dual 12" cabinet often specified by Jaffe Acoustics, not JBL product
4625B - 4-cu ft bass guitar and low-frequency box w/E140-8
4628B - 4-cu ft three-way all purpose system, E145-8, 2118H, 2404H-1*
4680B - column w/(4) E110, (2) 2402 (Obsolete)
4691B - 4-cu ft two-way all purpose system, E140-8, 2370A/2426J
4695B-4 - 10 cu ft subwoofer/bass guitar with E155-4
4698B - 10 cu ft three-way all purpose system, E155-4, E110-8, 2404H-1*
4699B - 10 cu ft three-way all purpose system, E155-4, E110-8, 2370A/2426H
4602CVR - hard cover for 4602B
4612CVR - hard cover for 4612B
4620CVR - hard cover for 4604B, 4625B, 4691B
4695CVR - hard cover for 4695B, 4698B, 4699B

NOTE: Cabaret version of the 2404 tweeter (2404H-1) uses D8R075 replacement diaphragm.
Unloaded Low Frequency Enclosures

4700 SOUND POWER SERIES COMPONENTS:

4716 - two-way passive crossove,small monitor w/ 2123h, 2342, 2416H
4726 - two-way, bi-amped full range small monitor w/2204H, 2344/2426H
4728 - two-way bi-amped full range small floor wedge monitor w/2204H, 2344/2426H
4742 - double 2204H direct-radiator subwoofer
4745 - double 2225H direct-radiator subwoofer
4748 - single 2240H direct-radiator subwoofer
4750 - two-way full range trapezoid enclosure w/2-2204H, 2380A/2445J
4751 - two-way full range trapezoid enclosure w/2-2204H, 2380A/2445J, 2-2404
4755 - two-way full range rectangular enclosure w/2-2204H, 2380A/2445J
4756 - two-way full range rectangular enclosure w/2-2204H, 2380A/2445J, 2-2404
4770 - two-way full-range trapezoid enclosure w/2-2225H, 2380A/2445J
4771 - two-way full-range trapezoid enclosure w/2-2225H, 2380A/2445J, 2-2404
4782 - Triple Chamber Bandpass sub-bass w/two 2204H
4785 - Triple Chamber Bandpass sub-bass w/two 2225H
4788 - Triple Chamber Bandpass sub-bass w/two 2240H

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

Sound Power Series Accessories:

MA2402 - 2402/04 MOUNTING ADAPTER PLATE
3700CA - 3700 CABLE PER METER
370 - 1.5 METER EP-8 CABLE
3 - 5 METER EP-8 CABLE
3733 - 10 METER EP-8 CABLE
3765 - 20 METER EP-8 CABLE
4700PNT - TOUCH UP PAINT FOR THE 4700 SERIES
4701PNL - XLR IN XLR OUT
4702PNL - XLR IN EP-8 OUT
4710PNL - POWER PANEL
4716BRK - 4716 MOUNTING BRACKET
4726BRK - 4726 MOUNTING BRACKET
N4726 - 4726/ 4728 PASSIVE CROSSOVER NETWORK
4750CVR - COVER FOR THE 4750
4750DL - DOLLY FOR THE 4750
N4750 - 4750/ 4755/ 4770 PASSIVE CROSSOVER WITH POWER CORRECTION
4750PC - 4750/ 4755/ 4770 PASSIVE POWER CORRECTION FOR ACTIVE CROSSOVERS
4755BRK - 4755 MOUNTING BRACKET
4770CVR - COVER FOR THE 4770
4770DL - DOLLY FOR THE 4770
4782CVR - COVER FOR THE 4782
4785DL - DOLLY FOR THE 4785
4788DL - DOLLY FOR THE 4788
EP-8-11 - EP-8 FEMALE CABLE CONNECTOR
EP-8-12 - EP-8 MALE CABLE CONNECTOR
EP-8-13 - EP-8 FEMALE CHASSIS CONNECTOR
EP-8-14 - EP-8 MALE CHASSIS CONNECTOR

LOADED LOW FREQUENCY SYSTEMS:

4645 - 4518, 8 cubic foot VLF enclosure w/2245H 18" subwoofer
4646 - 4512, 1.2 cubic ft LF enclosure w/2204H 12" woofer
4647 - 4507, 5 cubic foot LF enclosure w/2225H 15" woofer
4648 - 4508, 8 cubic foot LF enclosure w/two 2225H 15" woofers

ENCLOSED UTILITY SYSTEMS:

4612OK - oak vinyl covered version of 4612B for fixed installations
4660 - Defined Coverage "instant cluster" hanging speaker system
4671OK - oak vinyl, self-contained version of 4671 theater system

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

THEATER/SOUND REINFORCEMENT SYSTEMS: (assembled by customer)

4662A - two-way system, 4560BKA, E140-8, 2370A/2426J
4663A - three-way system, 4560BKA, E140-8, 2370A/2426J, 2405H
4670B - two-way system, 4508, (2) 2225H, 2380A/2445J, 3160
4671 - two-way system, 4507, 2225H, 2370A/2426J, 3110A
4672A - two-way system, 4560BKA, 2225H, 2370A/2426J, 3110A
4673 - two-way system, 4507, 2225H, 2380A/2445J, 3115A
4674A - two-way system, 4560BKA, 2225H, 2380A/2445J, 3115A
4675A - two-way system, 4508, (2) 2225H, 2360A/2445J, 3160, 2506
4675A-2 - two-way system, (2) 4508, (4) 2225J, 2360A/2445J, 3160, 2506
4676B-1 - two-way system, 4550BKA, (2) 2225H, 2360A/2445J, 3160, 2506
4676B-2 - two-way system, (2) 4550BKA, (4) 2225J, (2) 2365A/2445J,(2) 3160,(1) 9375,

NOTE: All Theater System orders should include a copy of JBL Tech Note: "Instruction Manual - Motion Picture Loudspeaker Systems".

4800 CONCERT SERIES COMPONENTS:

4825 - two-way full range small monitor w/2204H, 2344/2426H
4828 - two-way full range small floor wedge monitor w/2204H, 2344/2426H
4842 - double 2245H direct-radiator subwoofer
4845 - single 2245H direct-radiator subwoofer
4847 - single 2225H direct-radiator low frequency driver
4850 - two-way full range small column w/2-2204H, 2380A/2445J
4851 - two-way full range small column w/2-2204H, 2380A/2445J, 2-2404
4852 - two-way full range small column w/2-2204H, 2385A/2445J
4853 - two-way full range small column w/2-2204H, 2385A/2445J, 2-2404
4850DL - speaker dolly for all 4850 models
4860 - single 2380A/2445J in heavy road cabinet
4862 - single 2385A/2445J in heavy road cabinet
4863 - single 2385A/2445J, (2) 2404H in heavy road cabinet
4866 - two 2386/2445J in heavy road cabinet
4870 - two-way full-range w/2-2225H, 2380A/2445J
4871 - two-way full-range w/2-2225H, 2380A/2445J, 2-2404
4872 - two-way full-range w/2-2225H, 2385A/2445J,
4873 - two-way full-range w/2-2225H, 2385A/2445J, 2-2404
4870DL - speaker dolly for all 4870 and 4840 models

4900 CONCERT SERIES COMPLETE PACKAGED SYSTEMS:

4921 (2) 4850 or 4852, 9922 rack, (2) 3850 cables
4921T (2) 4851 or 4853, 9922 rack, (2) 3850 cables
4922 (2) 4870 or 4872, 9922 rack, (2) 3850 cables
4922T (2) 4871 or 4873, 9922T rack, (2) 3850 cables
4923 (2) 4870 or 4872, (2) 4845, 9923 rack, (2) 3850 + (2) 3805 cables
4923T (2) 4871 or 4873, (2) 4845, 9923T rack, (2) 3850 + (2) 3805 cables
4924 (2) 4850 or 4852, (2) 4845, 9923 rack, (2) 3850 + (2) 3805 cables
4924T (2) 4851 or 4853, (2) 4845, 9923T rack, (2) 3850 + (2) 3805 cables
4925 (2) 4825, 9922 rack, (2) 3850 cables
4926 (4) 4825, 9922 rack, (2) 3850 + (2) 3805 cables
4927 (8) 4825, 9942 rack, (4) 3850 + (4) 3805 cables
4941 (4) 4850 or 4852, 9942 rack, (4) 3850 cables
4941 (4) 4851 or 4853, 9942T rack, (4) 3850 cables
4942 (4) 4870 or 4872, 9942 rack, (4) 3850 cables
4942T (4) 4871 or 4873, 9942T rack, (4) 3850 cables
4943 (4) 4870 or 4872, (4) 4845, 9943 rack, (4) 3850 + (4) 3805 cables
4943T (4) 4871 or 4873, (4) 4845, 9943T rack, (4) 3850 + (4) 3805 cables
4944 (4) 4850 or 4852, (2) 4842, 9943 rack, (4) 3850 + (2) 3805 cables
4944T (4) 4851 or 4853, (2) 4842, 9943T rack, (4) 3850 + (2) 3805 cables
4945 (2) 4825, (2) 4845, 9923 rack, (2) 3850 + (2) 3805 cables
4946 (4) 4825, (2) 4842, 9923 rack, (4) 3850 + (2) 3805 cables

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

9900 CONCERT SERIES ACCESSORIES:

9916RC - road case for 9920 electronics rack
9920RC - road case for 9940 electronics rack
3805 - 5-foot speaker cable
3850 - 50-foot speaker cable
MT4612 - tripod for 4825 speakers

5000 SERIES: SIGNAL-LEVEL ELECTRONICS

5234A - Electronic frequency dividing network and Plug-in cards
5235 - Replacing 5234A sometime in 1987 - functionally identical
5330 - six-channel mixer with VCA control
5336 - six-channel plug-in VCA channel control card for 5330
5547A - 1/3 octave boost/cut general purpose graphic equalizer
5549A - 1/3 octave cut-only graphic room equalizer
SC5 - security cover for 5530, 5547, 5549

NOTE: 5234, 5234A and 5235 will all work with all current plug-in cards.

PLUG-IN CROSSOVER CARDS FOR 5234A or 5235:

CROSSOVER CARD CODE:

51-xxxx - 18 dB/octave
52-xxxx - 12 dB/octave
xx-51xx - no EQ
xx-52xx - Constant Coverage Bi-Radial EQ (2344, 2360, 2365, 2366 horns)
xx-53xx - Flat Front Bi-Radial EQ (2370, 2380, 2382, 2385, 2386 horns)

CARD SALES MODEL NUMBERS:

51-5130 - blank 18 dB/octave
51-5132 - 500 Hz/18 dB/octave
51-5133 - 800 Hz/18 dB/octave
51-5138 - 80 Hz/18 dB/octave (for all JBL subwoofer systems)
51-5145 - 290 Hz/18 dB/octave (for the 4345,4344 and 4355 Studio Monitors)
51-5232 - 500 Hz/18 dB/octave CCBREQ (for 2360 series horns)
51-5233 - 800 Hz/18 dB/octave CCBREQ (for 2360 series horns)
51-5332 - 500 Hz/18 dB/octave FFBREQ (for 2380 series horns)
51-5333 - 800 Hz/18 dB/octave FFBREQ (for 2380 series horns)
51-5334 - 1200 Hz/18 dB/octave FFBREQ (for 2370 & 80 series horns)
51-5336 - 1600 Hz/18 dB/octave FFBREQ (for 2370 & 80 series horns)
52-5120 - blank 12 dB/octave
52-5121 - 250 Hz/12 dB/octave
52-5122 - 500 Hz/12 dB/octave
52-5123 - 800 Hz/12 dB/octave
52-5124 - 1200 Hz/12 dB/octave
52-5125 - 5000 Hz/12 dB/octave
52-5127 - 7000 Hz/12 dB/octave
52-5130 - for 4430 & 4435 studio monitors
52-5140 - for 4350 & 4355 (Obsolete) studio monitors
52-5222 - 500 Hz/12 dB/octave CCBREQ (2360 series)
52-5223 - 800 Hz/12 dB/octave CCBREQ (2360 series)
52-5322 - 500 Hz/12 dB/octave FFBREQ (2380 series)
52-5323 - 800 Hz/12 dB/octave FFBREQ (2380 series)

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

6200 SERIES: AMPLIFIERS AND AUTOFORMERS/TRANSFORMERS

6210 - amp; 35 W/8 ohm, 45 W/4 ohm (single channel amp, mounts on speaker)
6211 - amp; 35 W/8 ohm, 45 W/4 ohm (like 6210, with mic/line input (XL))
6215 - amp; 35 W/ch - 8 ohm, 70 W bridged - 8 ohm
6230 - amp; 75 W/ch - 8 ohm, 150 W/ch - 4 ohm, 300 W bridged - 8 ohm
6260 - amp; 150 W/ch - 8 ohm, 300 W/ch - 4 ohm, 600 W bridged - 8 ohm
6290 - amp; 300 W/ch - 8 ohm, 600 W/ch - 4 ohm, 1200 W bridged - 8 ohm
6200SC - security cap set for securing amp level controls
6218 - 45 W autoformer 4 ohm to 109 ohm (27:1 impedance ratio)
9375 - 150 W autoformer 4 ohm to 36 ohm (9:1 impedance ratio)
6238 - 150 W transformer 4 ohm to 36 ohm "
6267 - 300 W autoformer 4 ohm to 16 ohm (4:1 impedance ratio)
6268 - 300 W transformer 4 ohm to 16 ohm "
6297 - 600 W autoformer 4 ohm to 8 ohm (2:1 impedance ratio)
6298 - 600 W transformer 4 ohm to 8 ohm "

6800 SERIES: VIDEO PRODUCTS

6810 - Video Projector-Nominal 120v, NTSC, Built in 10W amp and US NTSC Tuner
6820 - Video Projector-Nominal 220v, NTSC/PAL with Automatic Switching
MA6810.-.Ceiling Mount for the 6810 and 6820
VG-1 - Convergence pattern generator for 6810/6820 setup

7000 SERIES: SPECIAL ELECTRONICS

7110 - New fully adjustable single rack space compressor/limiter
7510B - Automatic microphone mixer, 4 to 24 inputs, individual outputs
7510-03 - four input module for 7510B
7922 - Digital Delay, 200 microseconds to 327 milliseconds, 1 in, 2 out
U16-14550 -.Line Level output transformer for the 7110,

8000 SERIES: INDUSTRIAL SERIES LOUDSPEAKERS

8110H - 5" ceiling loudspeaker
8120H - 8" ceiling loudspeaker
8130H - 8" ceiling loudspeaker
8140H - 8" "Co-Motional" ceiling loudspeaker (true coaxial loudspeaker)
8216A - two-way system, 6.5" woofer, dome tweeter
8216AT - 8216 w/built-in 8- ohm and 16, 8, 4, 2 watt, 70 volt transformer
8325A - three-way system, 10" woofer, 5" mid, dome tweeter
8325B - three-way system for motion picture theater surround use
8330 - three-way system for motion picture theater surround use, trapezoidal
WB8 - ceiling-mount grille for 8" loudspeakers

NOTE: INDUSTRIAL SERIES LOUDSPEAKER OPTION SUFFIXES:
H - loudspeaker only
HT - loudspeaker with 70/25-volt transformer attached
HTWB - loudspeaker assembled with transformer and grille

9000 SERIES: AUTOTRANSFORMERS

9315HT - 5-watt, 70-volt transformer for I-series (8100) loudspeakers
9 - 100-watt autoformer with 2:1, 4:1 and 8:1 impedance ratio taps 4, 8, 16, an

PERFORMANCE SERIES (G-series) SYSTEMS:

G-730 - two-way system w/G125-8 & G-791
G-731 - dual-angle floor monitor wedge w/G-730 components
G-732 - two-way, horn loaded system w/G-135A-8 & G-971
G-733 - three-way system w/MI-10, 2118 & G-791

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

G-734 - two-way, direct radiator system w/G135A-8 & G-791
G-791 - High Frequency power pack w/2371 horn, 2416H driver and network

MUSICAL INSTRUMENT LOUDSPEAKERS LOUDSPEAKERS:

E110-8 - 10" wide range, guitar, vocal
E120-8,-16 - 12" wide range, guitar, bass, vocal
E130-8 - 15" wide range, guitar, bass, vocal
E140-8 - 15" bass guitar, general purpose bass
E145-8 - 15" general purpose bass
E155-8,-4 - 18" general purpose bass

G125-8 - 12" guitar, bass, vocal
G135A-8 - 15" guitar, bass, vocal

MI-10 - 10" guitar, vocal (used in G-733, not sales model)

TRANSDUCER SUFFIXES:

A = 8 ohm voice coil impedance - Alnico Magnet Structure
B = 16 ohm voice coil impedance - Alnico Magnet Structure
G = 4 ohm voice coil impedance - Ferrite Magnet Structure
H = 8 ohm voice coil impedance - Ferrite Magnet Structure
J = 16 ohm voice coil impedance - Ferrite Magnet Structure
-4 = 4 ohm voice coil impedance - Ferrite Magnet Structure
-8 = 8 ohm voice coil impedance - Ferrite Magnet Structure
-16 = 16 ohm voice coil impedance - Ferrite Magnet Structure

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

6200 SERIES: AMPLIFIERS AND AUTOFORMERS/TRANSFORMERS

6210 - amp; 35 W/8 ohm, 45 W/4 ohm (single channel amp, mounts on speaker)
6211 - amp; 35 W/8 ohm, 45 W/4 ohm (like 6210, with mic/line input (XL))
6215 - amp; 35 W/ch - 8 ohm, 70 W bridged - 8 ohm
6230 - amp; 75 W/ch - 8 ohm, 150 W/ch - 4 ohm, 300 W bridged - 8 ohm
6260 - amp; 150 W/ch - 8 ohm, 300 W/ch - 4 ohm, 600 W bridged - 8 ohm
6290 - amp; 300 W/ch - 8 ohm, 600 W/ch - 4 ohm, 1200 W bridged - 8 ohm
6200SC - security cap set for securing amp level controls
6218 - 45 W autoformer 4 ohm to 109 ohm (27:1 impedance ratio)
9375 - 150 W autoformer 4 ohm to 36 ohm (9:1 impedance ratio)
6238 - 150 W transformer 4 ohm to 36 ohm "
6267 - 300 W autoformer 4 ohm to 16 ohm (4:1 impedance ratio)
6268 - 300 W transformer 4 ohm to 16 ohm "
6297 - 600 W autoformer 4 ohm to 8 ohm (2:1 impedance ratio)
6298 - 600 W transformer 4 ohm to 8 ohm "

6800 SERIES: VIDEO PRODUCTS

6810 - Video Projector-Nominal 120v, NTSC, Built in 10W amp and US NTSC Tuner
6820 - Video Projector-Nominal 220v, NTSC/PAL with Automatic Switching
MA6810.-.Ceiling Mount for the 6810 and 6820
VG-1 - Convergence pattern generator for 6810/6820 setup

7000 SERIES: SPECIAL ELECTRONICS

7110 - New fully adjustable single rack space compressor/limiter
7510B - Automatic microphone mixer, 4 to 24 inputs, individual outputs
7510-03 - four input module for 7510B
7922 - Digital Delay, 200 microseconds to 327 milliseconds, 1 in, 2 out
U16-14550 -.Line Level output transformer for the 7110,

8000 SERIES: INDUSTRIAL SERIES LOUDSPEAKERS

8110H - 5" ceiling loudspeaker
8120H - 8" ceiling loudspeaker
8130H - 8" ceiling loudspeaker
8140H - 8" "Co-Motional" ceiling loudspeaker (true coaxial loudspeaker)
8216A - two-way system, 6.5" woofer, dome tweeter
8216AT - 8216 w/built-in 8- ohm and 16, 8, 4, 2 watt, 70 volt transformer
8325A - three-way system, 10" woofer, 5" mid, dome tweeter
8325B - three-way system for motion picture theater surround use
8330 - three-way system for motion picture theater surround use, trapezoidal
WB8 - ceiling-mount grille for 8" loudspeakers

NOTE: INDUSTRIAL SERIES LOUDSPEAKER OPTION SUFFIXES:
H - loudspeaker only
HT - loudspeaker with 70/25-volt transformer attached
HTWB - loudspeaker assembled with transformer and grille

9000 SERIES: AUTOTRANSFORMERS

9315HT - 5-watt, 70-volt transformer for I-series (8100) loudspeakers
9 - 100-watt autoformer with 2:1, 4:1 and 8:1 impedance ratio taps 4, 8, 16, an

PERFORMANCE SERIES (G-series) SYSTEMS:

G-730 - two-way system w/G125-8 & G-791
G-731 - dual-angle floor monitor wedge w/G-730 components
G-732 - two-way, horn loaded system w/G-135A-8 & G-971
G-733 - three-way system w/MI-10, 2118 & G-791

JBL COMPONENT LISTING BY NUMERICAL CATEGORY - AS OF 4/20/89

G-734 - two-way, direct radiator system w/G135A-8 & G-791
G-791 - High Frequency power pack w/2371 horn, 2416H driver and network

MUSICAL INSTRUMENT LOUDSPEAKERS LOUDSPEAKERS:

E110-8 - 10" wide range, guitar, vocal
E120-8,-16 - 12" wide range, guitar, bass, vocal
E130-8 - 15" wide range, guitar, bass, vocal
E140-8 - 15" bass guitar, general purpose bass
E145-8 - 15" general purpose bass
E155-8,-4 - 18" general purpose bass

G125-8 - 12" guitar, bass, vocal
G135A-8 - 15" guitar, bass, vocal

MI-10 - 10" guitar, vocal (used in G-733, not sales model)

TRANSDUCER SUFFIXES:

A = 8 ohm voice coil impedance - Alnico Magnet Structure
B = 16 ohm voice coil impedance - Alnico Magnet Structure
G = 4 ohm voice coil impedance - Ferrite Magnet Structure
H = 8 ohm voice coil impedance - Ferrite Magnet Structure
J = 16 ohm voice coil impedance - Ferrite Magnet Structure
-4 = 4 ohm voice coil impedance - Ferrite Magnet Structure
-8 = 8 ohm voice coil impedance - Ferrite Magnet Structure
-16 = 16 ohm voice coil impedance - Ferrite Magnet Structure

JBL LOUDSPEAKER MOUNTING HOLE AND BOLT CIRCLE DIMENSIONS:

	mounting holes:	bolt circles:
for 8" drivers:	7 - 1/16 "	7 - 5/8 "
for 10" drivers:	9 "	9 - 3/4 "
for 12" drivers:	11 - 1/16 "	11 - 9/16 "
for 15" drivers:	13 - 31/32 "	14 - 9/16 "
for 18" drivers:	16 - 13/16 "	17 - 3/8 "

VOLUME DISPLACED BY JBL LOUDSPEAKERS:

10" drivers = .1 cubic foot
12" drivers = .15 cubic foot
15" drivers = .2 cubic foot
18" drivers = .3 cubic foot

USEFUL CONVERSION FACTORS AND PHYSICAL FORMULAS

liters	feet^3	inches^3	meters^3
.016387	.000578	1	.0000164
1	.0353	61.0	.001
28.32	1	1,728	.02832
1000	35.31	61,024	1

feet	inches
1	12
.08333	1
3.281	39.37

SOUND VELOCITY:

meters/second	feet/second	inches/second	temp
342.5	1125	13,500	20 C
344	1130	13,560	22 C

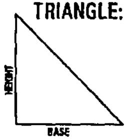
SOUND WAVE LENGTH = velocity / frequency
FREQUENCY = velocity / wavelength

AREA OF CIRCLE = pi (radius^2) [radius = 1/2 diameter]
DIAMETER OF CIRCLE = 2 [$\sqrt{(\text{area/pi})}$] [pi = 3.1416]

VOLUME OF TUBULAR DUCT = (circular area)(length)
VOLUME OF TRIANGULAR BOX SECTION = (1/2 base)(height)(length)

MENSURATION FORMULAE FOR COMMON SHAPES, compiled by Drew Daniels, 10-88

TRIANGLE:

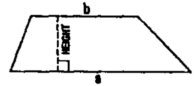


AREA = .5 BASE×HEIGHT

PARALLELOGRAM:

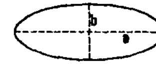
AREA = BASE×HEIGHT

TRAPEZOID:



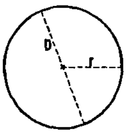
AREA = .5 HEIGHT×(a+b)

ELLIPSE:



AREA = π a b

CIRCLE:

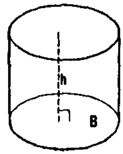


AREA = πr^2

CIRCUMFERENCE = π D

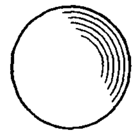
DIAMETER = $2 \times \sqrt{area/\pi}$

CYLINDER:



VOLUME = Bh

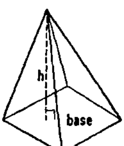
SPHERE:



SURFACE AREA = $4\pi r^2$

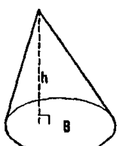
VOLUME = $4\pi r^3/3$

PYRAMID:



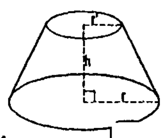
VOLUME = |base×h

CONE:



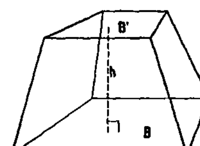
VOLUME = $\frac{1}{3}$Bh

CONE FRUSTUM:

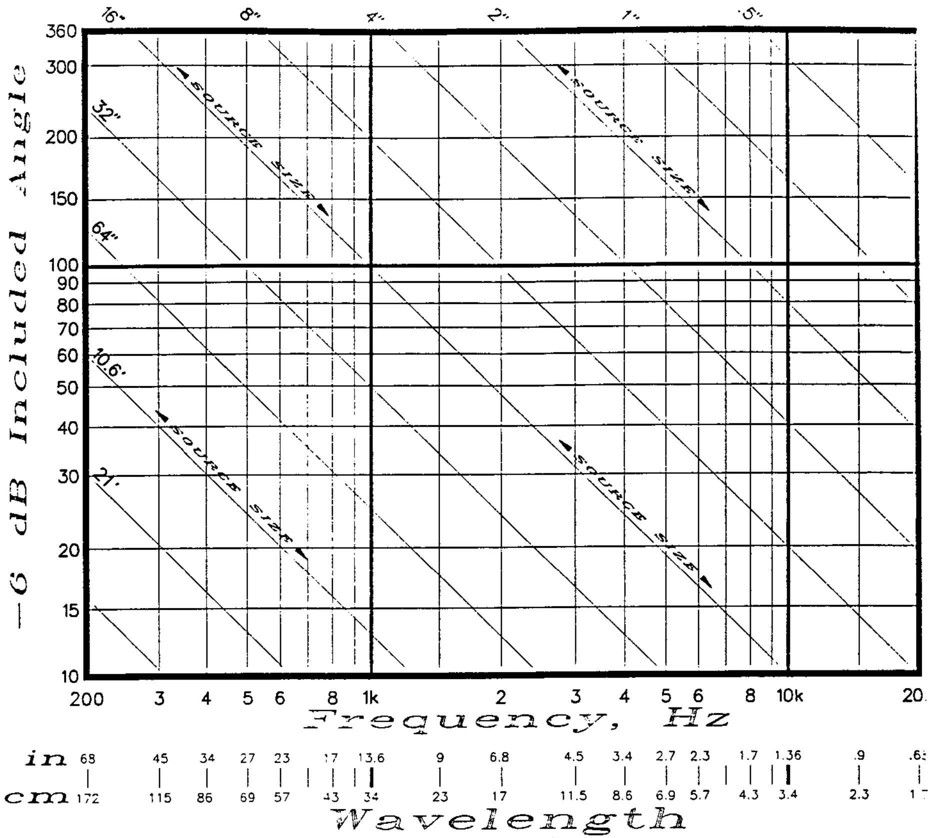


V = $\frac{1}{3}$ h×(r² + , + r×r')

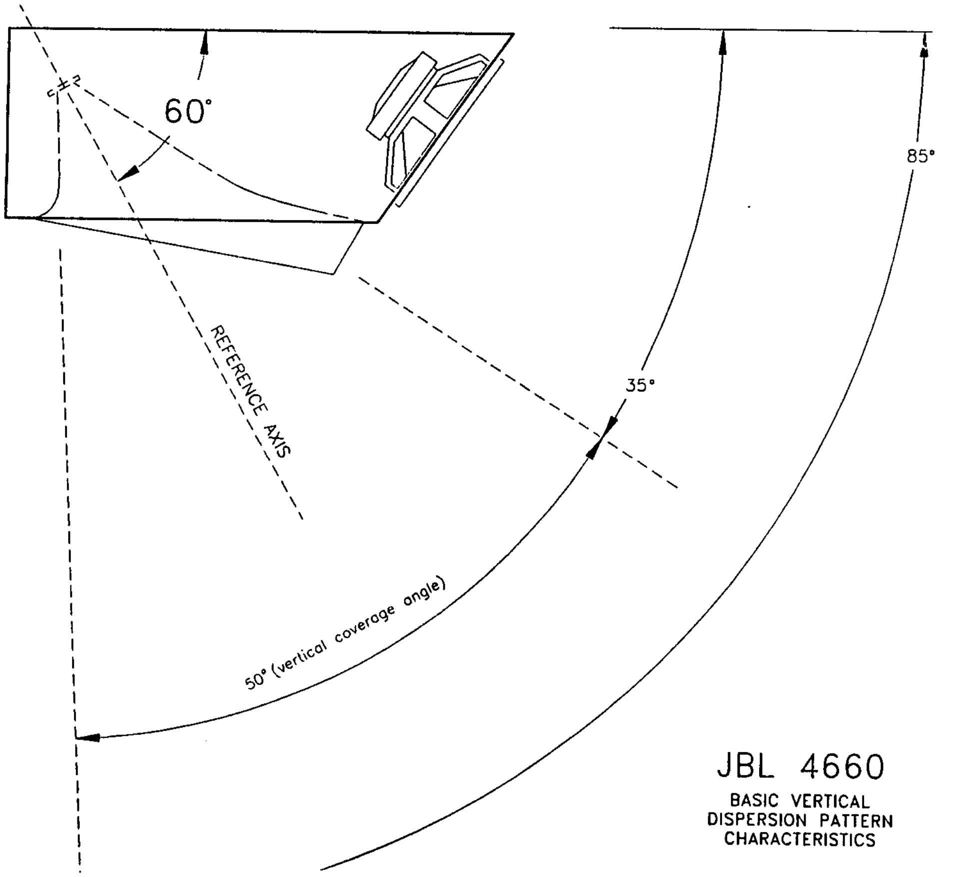
PYRAMID FRUSTUM:



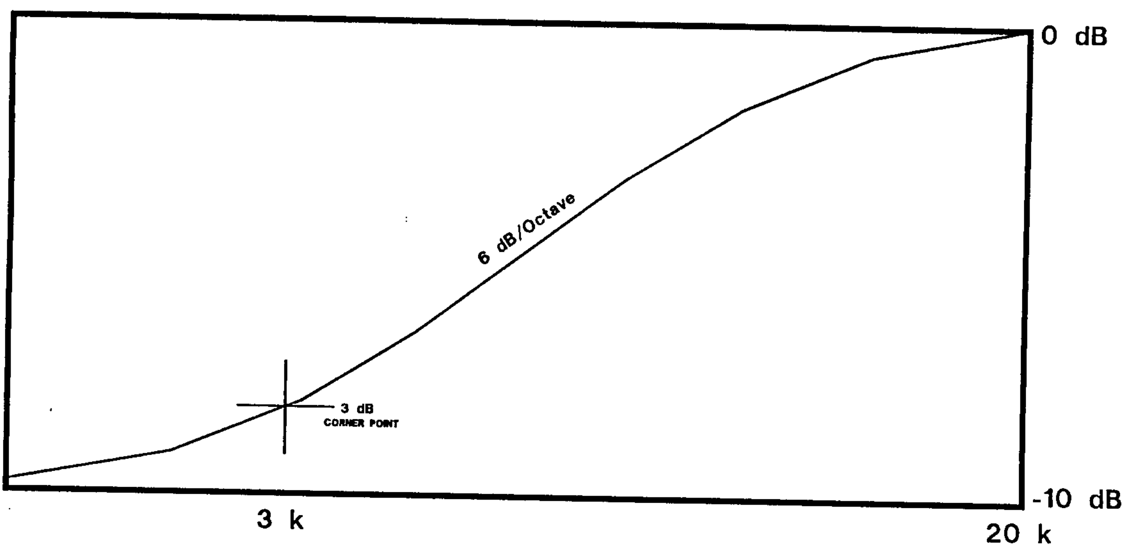
VOLUME = 1/3 h×(B + B' + √(B B')



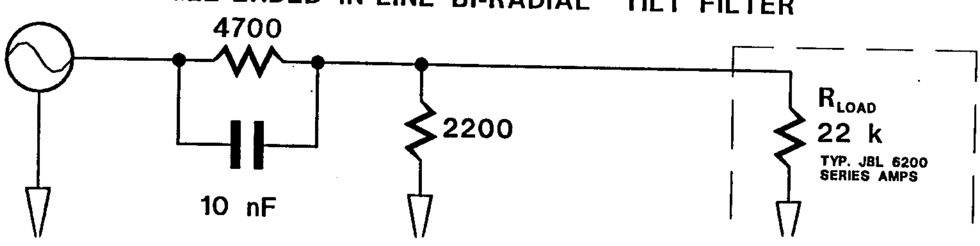
Radiation angle or included angle of dispersion of loudspeakers is a function of source size and sound wave length, not brand, model or cost, as some advertising seeks to represent. Flat baffles such as wall surfaces or ceilings tend to force half-space radiation of low frequencies (long wavelengths) from flush-mounted sources, with the -6 dB points at about 80 degrees off axis, or 160 degrees included angle. As frequency rises and wavelengths shrink to near the size of the aperture of the sound source, beaming takes place. This frequency-dependent beaming can be regarded, for simplicity, as starting its narrowing when the wavelength shrinks to the circumference, or about three times the diameter, of the source. Thus an 8-inch ceiling speaker with a grille opening of 6.5 inches in diameter will exhibit at least a 90 degree included angle of dispersion to nearly 3 kHz, and a speaker with a coaxially mounted tweeter of smaller dimension can maintain wide dispersion to even higher frequencies.



JBL 4660
BASIC VERTICAL
DISPERSION PATTERN
CHARACTERISTICS

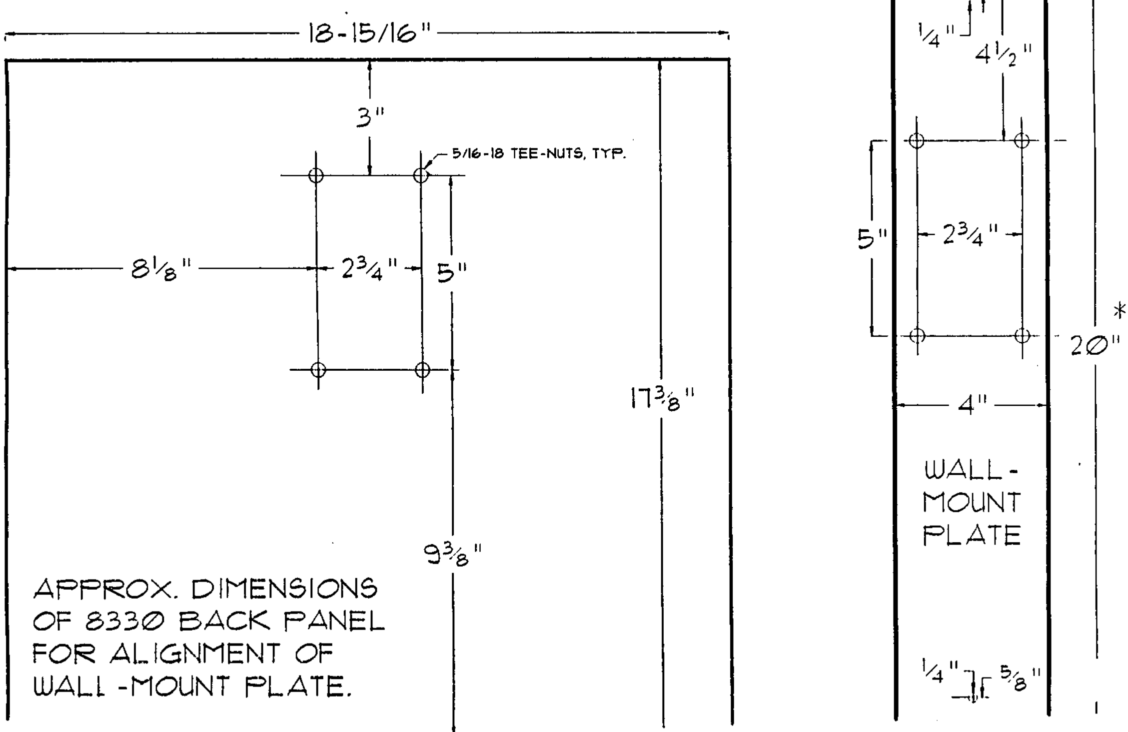


SINGLE-ENDED IN-LINE BI-RADIAL™ TILT FILTER



DETAIL OF WALL-MOUNTING PLATE FOR JBL 8330 SURROUND SPEAKER SYSTEM.
USE 1/4" FINNISH BIRCH PLYWOOD OR OTHER STURDY MATERIAL NOT LIKELY TO BE AFFECTED BY MOISTURE. PAINT TO SUIT, AND DRILL SIX HOLES AS SHOWN.
SECURE PLATE TO CABINET USING FOUR 5/16-18 MACHINE BOLTS.
SECURE PLATE TO WALL USING TWO HEAVY WOOD LAG BOLTS TO STUDS, OR TWO HEAVY (AT LEAST 1/4") TOGGLE BOLTS TO LATH & PLASTER WALLS, OR TWO HEAVY (1/4") MOLY BOLTS TO CONCRETE BLOCK CONSTRUCTION.

* Length of the bracket should be chosen for top/bottom clearance.



BUILDING MATERIAL	2 kHz ABSORPTION COEFFICIEN
ACOUSTIC TILE, 5/8", most mountings	.70
AUDIENCE, occupied seating area	.80
BALCONY, opening, deep, w/plush seats	.5 - 1.00
BRICK WALL, painted	.02
BRICK WALL, unpainted	.05
CARPET, rubber on concrete	.03
CARPET, Astroturf on concrete	.20
CARPET, thin pile on concrete	.27
CARPET, thin pile w/pad on concrete	.50
CARPET, heavy, on concrete	.60
CARPET, heavy, w/pad on concrete	.71
CONCRETE, poured or terrazzo	.02
CONCRETE FLOOR w/linoleum	.03
CONCRETE BLOCK, painted	.09
CONCRETE BLOCK, coarse *(porous)*	.39
COTTON, 14 oz, draped to 7/8 its area	.37
COTTON, 14 oz, draped to 1/2 its area	.66
DRAPE, 18 oz velour, draped 7/8	.45
DRAPE, 18 oz velour, draped 1/2	.70
FIBERGLASS, mat faced, 1" thick	.94
GLASS, plate, large panes	.02
GLASS, common window	.07
GRAVEL SOIL, loose and moist, 4"	.75
GRAVEL SOIL, loose and moist, 12"	.80
GYPSUM sheet rock, 1/2" on 2x4s/16" centers	.07
INTERIOR STUCCO, smooth, on tile	.04
MARBLE	.01
OZITE, .39 lb/square foot	.47
PINE FLOORING	.09
PLASTER, on hollow tile	.04
PLASTER, smooth, on wire lath & studs	.04
PLASTER, rough, on wire lath & studs	.06
PLYWOOD, 1/8" on 2x4 studs	.08
PLYWOOD, 3/8" paneling	.10
SAND, dry, 4" depth	.55
SAND, dry, 12" depth	.60
STAGE, open, depending on furnishings	.25 -.75
SONEX	.99
TECTUM, 1" panels hung under plenum	.50
TECTUM, 1" panels on 1" furring strips	.60
THEATER SEATS, plush, on hard floor	.80
VENETIAN BLINDS, 45 degrees, @ 5"	.13
WATER, as on swimming pool	.02
WOOD, hardwood plain or parquet floor	.06

LITERS		FT^3		$INCH^3$		$METER^3$
.016387	=	.0005787	=	1.0	=	.0000164
1.00	=	.0353146	=	61.0	=	.001
28.32	=	1.00	=	1,728	=	.02832
1000.00	=	35.31	=	61,024	=	1.00

MILLIMETER		INCH		METE
1.00	=	.039	=	.0
25.40	=	1.000	=	.02
1000.00	=	39.370	=	[illegible]

Sound Pressure dB SPL	Sound Pressure Pa	Sound Pressure bars	Intensity W/m^2	Air Particl Velocity
140	200 Pa	2 mbar	100 W	500 mm/
120	20 Pa	200 ubar	1 W	50 mm/
100	2 Pa	20 ubar	10 mW	5 mm/
80	200 mPa	2 ubar	100 uW	500 um/
60	20 mPa	200 nbar	1 uW	50 um/
40	2 mPa	20 nbar	10 nW	5 um/
20	200 uPa	2 nbar	100 pW	500 nm/
0	20 uPa	200 pbar	1 pW	50 nm/

note: 1 Pa (pascal) = 1 newton/m^2 20 uPa = 0.0002 dynes/c

SOUND WAVE LENGTH = velocity of sound divided by frequency (Hz)

FREQUENCY = velocity of sound divided by sound wavelength

SOUND VELOCITY = 344 m/s, 1130 ft/s or 13,560 in/s at 72 degrees F
" " = 342.5 m/s, 1125 ft/s, 13,500 in/s at 68 degrees F

AREA OF CIRCLE = 3.14 x (radius squared) [radius = 1/2 diameter

DIAMETER OF CIRCLE = 2 x [square root of (area/3.14)]

VOLUME OF TUBULAR DUCT = circular area x length

VOLUME OF TRIANGULAR BOX SECTION:
(1/2 base) x height x length

VOLUME DISPLACED BY CONE LOUDSPEAKERS:

10" drivers = .1 cubic foot
12" drivers = .15 cubic foot
15" drivers = .2 cubic foot
18" drivers = .3 cubic foot

LOUDSPEAKER MOUNTING HOLE AND BOLT CIRCLE DIMENSIONS:

	mounting holes:	bolt circles:
for 8" drivers =	7-1/16"	7-5/8"
for 10" drivers =	9"	9-3/4"
for 12" drivers =	11-1/16"	11-9/16"
for 15" drivers =	13-31/32"	14-9/16"
for 18" drivers =	16-13/16"	17-3/8"

MINIMUM POWERING REQUIREMENTS FOR LOUDSPEAKERS

People occasionally inquire about what minimum amplifier should work satisfactorily with a particular loudspeaker. To some, this question would seem strange, but upon review, even engineers may be reminded about the relationship of electrical power input to speaker loudnes

Reviewing some examples of typical loudness in daily experience:

0 dB = barely perceptible sound.
15 dB = recording studio silence level.
40 dB = residential area at night.
50 dB = average home or private office.
60 dB = face to face conversation.
70 dB = face to face heated debate.
80 dB = face to face shouting match.
90 dB = freeway traffic (moving).
100 dB = freeway traffic in tunnel.
110 dB = loud crowd in closed arena.
120 dB = jet takeoff at 100 meters.
130 dB = some permanent hearing loss.

1. **Find the loudspeaker's sensitivity rating (1 watt at 1 meter).**
2. **Find the distance from the speaker(s).**
3. **Determine the sound level requirement.**

The relationship between amplifier power and sound pressure is:

1 watt = 0 dB
2 watts = +3 dB
4 watts = +6 dB
10 watts = +10 dB (twice as loud as 1 watt)
20 watts = +13 dB
40 watts = +16 dB
100 watts = +20 dB (four times as loud as 1 watt)
200 watts = +23 dB
400 watts = +26 dB
1000 watts = +30 dB (eight times as loud as 1 watt)

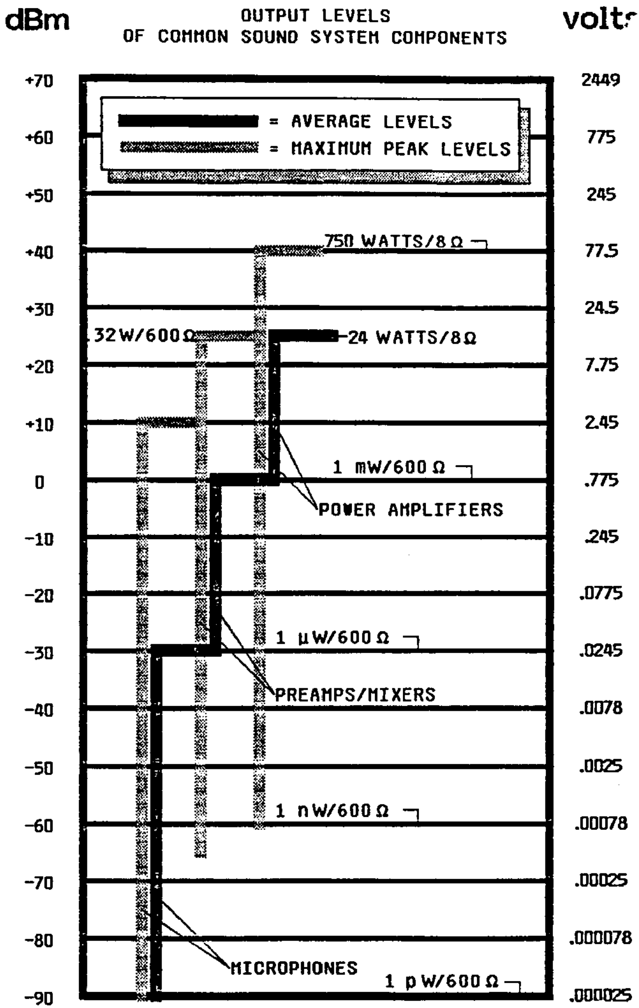
4. **Add the approximate number of dB to the sensitivity rating.**
5. **For a stereo set of speakers, add 3 dB to the rating.**

The relationship of distance to sound pressure in free space--outdoors--is as follows (in a room it will be louder):

1 meter = 0 dB
2 meters = -6 dB
3.2 meters = -10 dB (half as loud as 1 meter)
4 meters = -12 dB
6.3 meters = -16 dB
10 meters = -20 dB (one quarter as loud as 1 meter)
20 meters = -26 dB
32 meters = -30 dB (one eighth as loud as 1 meter)
40 meters = -32 dB
63 meters = -36 dB
100 meters = -40 dB (one sixteenth as loud as 1 meter)

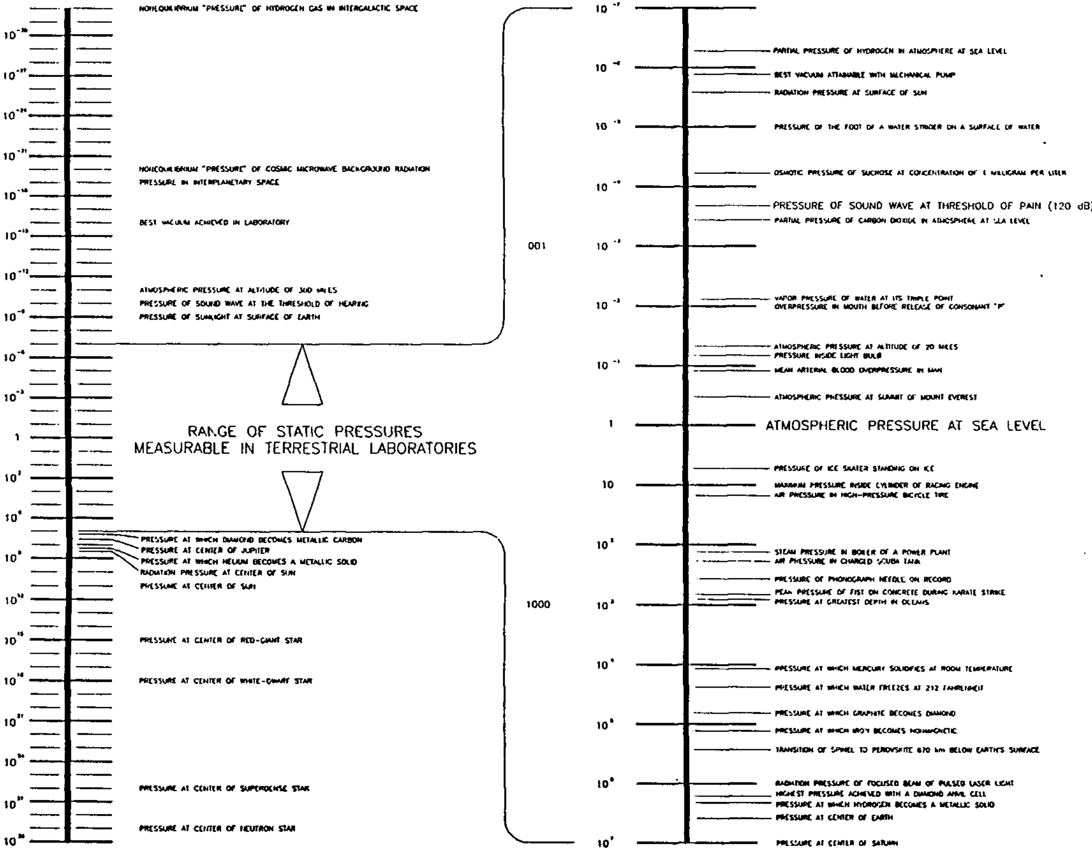
6. **Subtract the approximate number of dB from the last figure obtained.**

The result is now the minimum sound level developed by the particular speaker(s), with the power available, at the known distance.



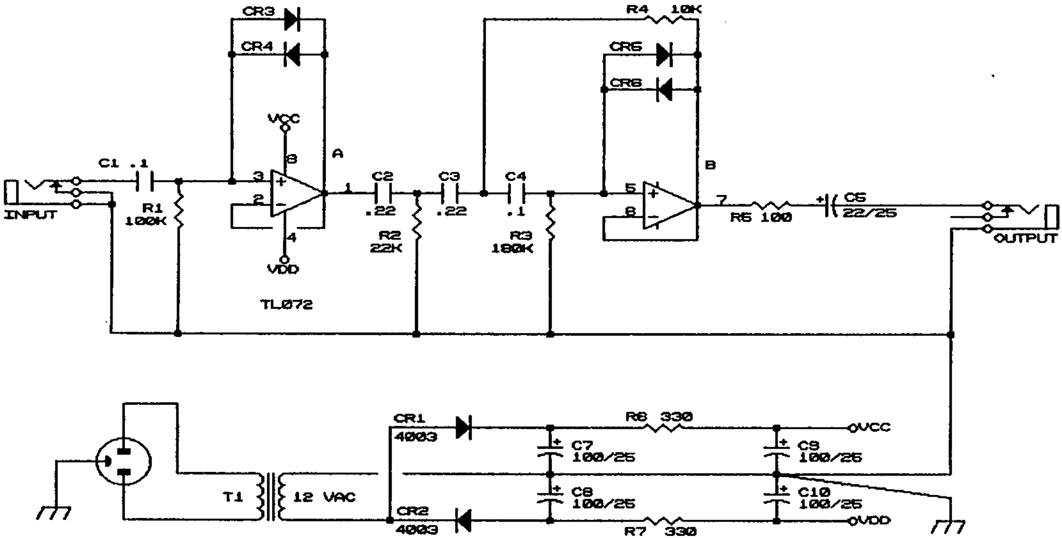
$$dB = 20 \times \log_{10} \frac{\text{voltage}_1}{\text{voltage}_2}$$

POWER = VOLTS SQUARED, DIVIDED BY OHMS



NONEQUILIBRIUM "PRESSURE" OF HYDROGEN GAS IN INTERGALACTIC SPACE
10^{-30}
10^{-27}
10^{-24}
10^{-21}
NONEQUILIBRIUM "PRESSURE" OF COSMIC MICROWAVE BACKGROUND RADIATION
PRESSURE IN INTERPLANETARY SPACE
10^{-18}
BEST VACUUM ACHIEVED IN LABORATORY
10^{-15}
10^{-12}
ATMOSPHERIC PRESSURE AT ALTITUDE OF 300 MILES
PRESSURE OF SOUND WAVE AT THE THRESHOLD OF HEARING
10^{-9}
PRESSURE OF SUNLIGHT AT SURFACE OF EARTH
10^{-6}
10^{-3}
1
RANGE OF STATIC PRESSURES
MEASURABLE IN TERRESTRIAL LABORATORIES
10^{3}
10^{6}
PRESSURE AT WHICH DIAMOND BECOMES METALLIC CARBON
PRESSURE AT CENTER OF JUPITER
10^{9}
PRESSURE AT WHICH HELIUM BECOMES A METALLIC SOLID
RADIATION PRESSURE AT CENTER OF SUN
PRESSURE AT CENTER OF SUN
10^{12}
10^{15}
PRESSURE AT CENTER OF RED-GIANT STAR
10^{18}
PRESSURE AT CENTER OF WHITE-DWARF STAR
10^{21}
10^{24}
PRESSURE AT CENTER OF SUPERDENSE STAR
10^{27}
PRESSURE AT CENTER OF NEUTRON STAR
10^{30}
001
1000
10^{-7}
PARTIAL PRESSURE OF HYDROGEN IN ATMOSPHERE AT SEA LEVEL
10^{-6}
BEST VACUUM ATTAINABLE WITH MECHANICAL PUMP
RADIATION PRESSURE AT SURFACE OF SUN
10^{-5}
PRESSURE OF THE FOOT OF A WATER STRIDER ON A SURFACE OF WATER
OSMOTIC PRESSURE OF SUCROSE AT CONCENTRATION OF 1 MILLIGRAM PER LITER
10^{-4}
PRESSURE OF SOUND WAVE AT THRESHOLD OF PAIN (120 dB)
PARTIAL PRESSURE OF CARBON DIOXIDE IN ATMOSPHERE AT SEA LEVEL
10^{-3}
VAPOR PRESSURE OF WATER AT ITS TRIPLE POINT
10^{-2}
OVERPRESSURE IN MOUTH BEFORE RELEASE OF CONSONANT "P"
ATMOSPHERIC PRESSURE AT ALTITUDE OF 20 MILES
PRESSURE INSIDE LIGHT BULB
10^{-1}
MEAN ARTERIAL BLOOD OVERPRESSURE IN MAN
ATMOSPHERIC PRESSURE AT SUMMIT OF MOUNT EVEREST
1
ATMOSPHERIC PRESSURE AT SEA LEVEL
PRESSURE OF ICE SKATER STANDING ON ICE
10
MAXIMUM PRESSURE INSIDE CYLINDER OF RACING ENGINE
AIR PRESSURE IN HIGH-PRESSURE BICYCLE TIRE
10^{2}
STEAM PRESSURE IN BOILER OF A POWER PLANT
AIR PRESSURE IN CHARGED SCUBA TANK
PRESSURE OF PHONOGRAPH NEEDLE ON RECORD
PEAK PRESSURE OF FIST ON CONCRETE DURING KARATE STRIKE
10^{3}
PRESSURE AT GREATEST DEPTH IN OCEANS
10^{4}
PRESSURE AT WHICH MERCURY SOLIDIFIES AT ROOM TEMPERATURE
PRESSURE AT WHICH WATER FREEZES AT 212 FAHRENHEIT
PRESSURE AT WHICH GRAPHITE BECOMES DIAMOND
10^{5}
PRESSURE AT WHICH IRON BECOMES NONMAGNETIC
TRANSITION OF SPINEL TO PEROVSKITE 670 km BELOW EARTH'S SURFACE
10^{6}
RADIATION PRESSURE OF FOCUSED BEAM OF PULSED LASER LIGHT
HIGHEST PRESSURE ACHIEVED WITH A DIAMOND ANVIL CELL
PRESSURE AT WHICH HYDROGEN BECOMES A METALLIC SOLID
PRESSURE AT CENTER OF EARTH
10^{7}
PRESSURE AT CENTER OF SATURN

COUNTRY	VOLTAGE(S)	FREQUENCY(S)
ALGERIA	127, 220	50 Hz
ARGENTINA	220	50
AUSTRALIA	220	50
AUSTRIA	230, 240	50
BELGIUM	110, 127, 220	50
BRAZIL	110, 115, 125, 220, 227	50, 60
CANADA	110, 115, 120	60
CHILE	220, (110)	50, (60)
CHINA	110, 220	50, 60
COLOMBIA	110, 115, 120	60
COSTA RICA	120	60
CUBA	110	60
CZECHOSLOVAKIA	220	50
DENMARK	220	50
DOMINICA	110	60
EQUADOR	110, 120, 127	60
EGYPT	110, 220	50
EL SALVADOR	110	60
ENGLAND	200, 210, 230, 240	50
FINLAND	220	50
FRANCE	110, 115, 120, 127, 220	50
GERMANY	110, 120, 127, 220	50
GUATEMALA	120, (220)	60
HAITI	115, (220)	60, (50)
HONDURAS	110	60
HUNGARY	220	50
INDIA	230	50
INDONESIA	110, 117	50
IRAN	220	50
IRAQ	220	50
ISRAEL	230	50
ITALY	110, 120, 127, 150, 160, 220	50
JAM[illegible]	110	50
JAP[illegible]	100	50, 60
KOREA	100	60 Hz
LEBANON	110, 220	50
LUXEMBOURG	110, 220	50
MALAYA	230	50
MEXICO	120, 127	50, 60
MONACO	220	50
MOROCCO	115, 127, 220	50
NETHERLANDS	127, 220	50
NEW ZEALAND	230	50
NICARAGUA	120	60
NIGERIA	230	50
NORWAY	220	50
OKINAWA	100	60
PAKISTAN	220, 230	50
PANAMA	110, 115, 120	60
PERU	200, (110)	60, (50)
PHILIPPINES	110, 220	60
POLAND	220	50
PORTUGAL	120, 220	50
RUMANIA	220. (110)	50
SAUDI ARABIA	120, 230	50, 60
SIERRA LEONE	230	50
SOVIET UNION	127	50, (45)
SPAIN	120, 127	50
SWEDEN	220, (117)	50
SWITZERLAND	220	50
SYRIA	115, 200	50
TAIWAN	110	60
THAILAND	220	50
TUNISIA	110, 115, 220	50
TURKEY	110, 220	50
URUGUAY	220	50
U.S.A.	115, 120	60
[illegible]	[illegible]	[illegible]

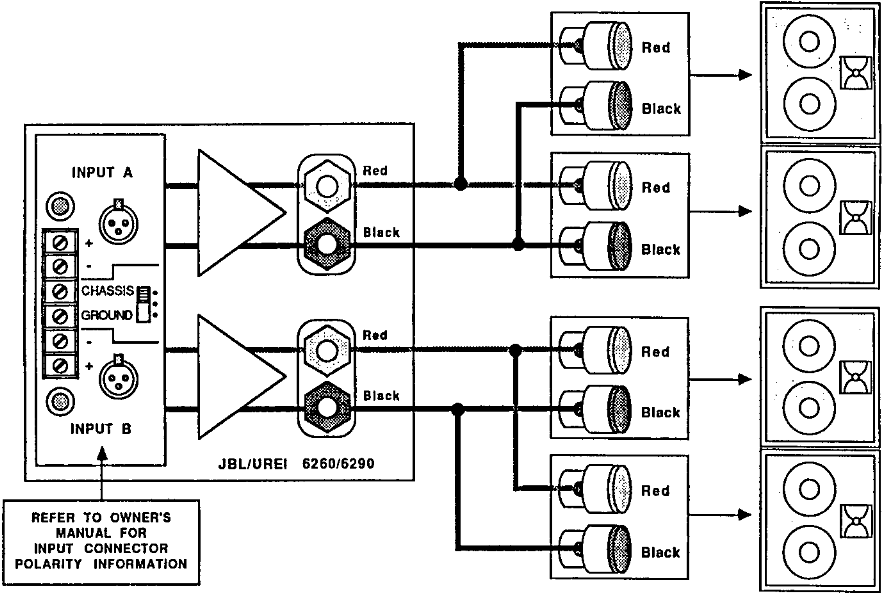


NOTES:

CR3 - CR6: 1N914
RESISTOR VALUES +/- 5% 1/2 W
CAPACITOR VALUES IN MICROFARADS
TO SHIFT F3 DOWN, INCREMENT THE VALUES OF
R1, R2, R3 AND R4 UP BY THE SAME
PERCENTAGE AS THE DIFFERENCE IN FREQUENCY.
(150k, 33k, 270k, AND 15k FOR F3 OF 30 Hz.

JBL/UREI ELECTRONICS	
Title: 30 Hz HIGH PASS FILTER	
Size: A	Document Number: 092688A
Date: September 27, 1988	Sheet 1 o

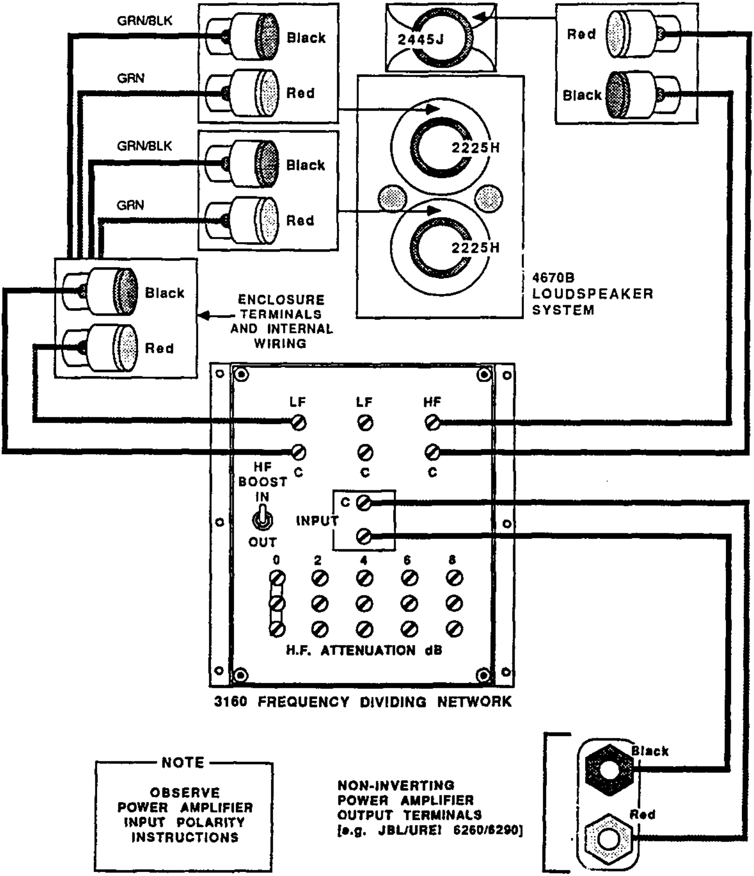
4612OK WIRING CONVENTION FOR ABSOLUTE POLARITY



ABSOLUTE POLARITY

A POSITIVE-GOING SIGNAL APPLIED TO THE "+" INPUT TERMINAL OF THE 6260/6290 POWER AMPLIFIER WILL RESULT IN FORWARD LOUDSPEAKER DIAPHRAGM MOVEMENT

4670B WIRING CONVENTION FOR ABSOLUTE POLARITY



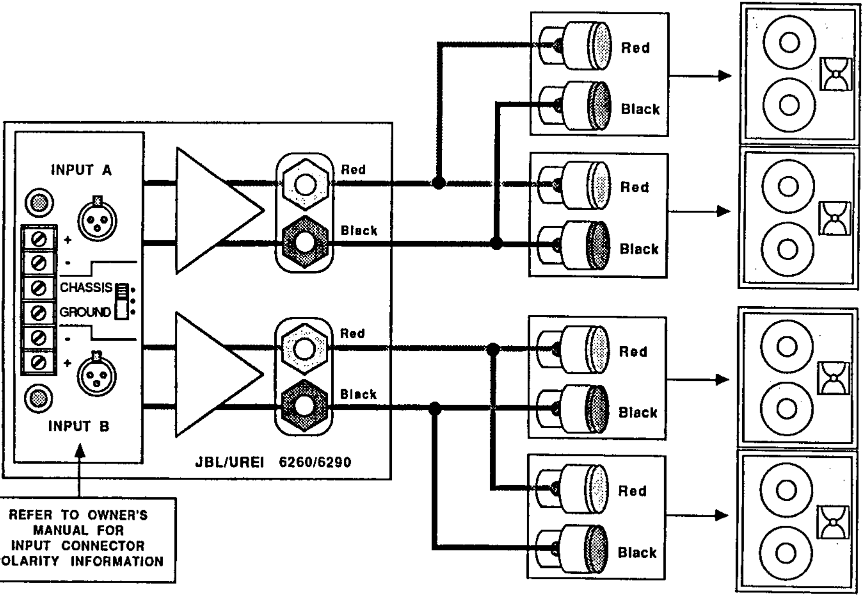
NOTE

OBSERVE POWER AMPLIFIER INPUT POLARITY INSTRUCTIONS

ABSOLUTE POLARITY

A POSITIVE-GOING SIGNAL APPLIED TO THE "+" INPUT TERMINAL OF THE 6260/6290 POWER AMPLIFIER WILL RESULT IN FORWARD LOUDSPEAKER DIAPHRAGM MOVEMENT

4612OK WIRING CONVENTION FOR ABSOLUTE POLARITY

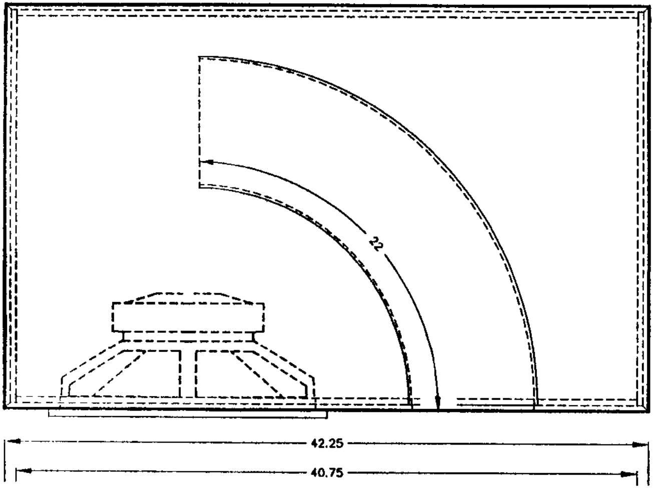


REFER TO OWNER'S MANUAL FOR INPUT CONNECTOR POLARITY INFORMATION

ABSOLUTE POLARITY

A POSITIVE-GOING SIGNAL APPLIED TO THE "+" INPUT TERMINAL OF THE 6260/6290 POWER AMPLIFIER WILL RESULT IN FORWARD LOUDSPEAKER DIAPHRAGM MOVEMENT

VENTED ENCLOSURE FOR JBL 2245H SUBWOOFER DRIVER



NOTES:

1. APPLY 2X4 BRACING TO ALL PANEL INTERIOR SURFACES. ONE-HALF CUBIC FOOT HAS BEEN ALLOWED FOR BRACING VOLUME.

2. APPLY R25 OR R30 FIBERGLASS PADDING TO ALL INTERIOR SURFACES.

3. EDGE CONSTRUCTION SHOWN IS EXAMPLE; OTHER METHODS MAY BE USED AS NEEDED, AS LONG AS JOINTS ARE AIR-TIGHT.

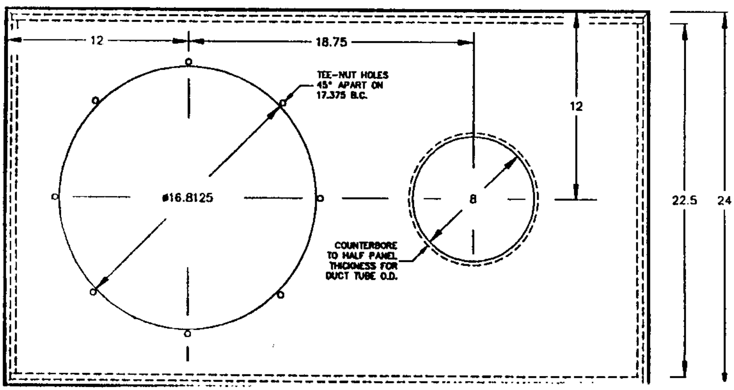
4. USE ONLY VOID-FREE, HIGH DENSITY MATERIAL FOR PANELS.

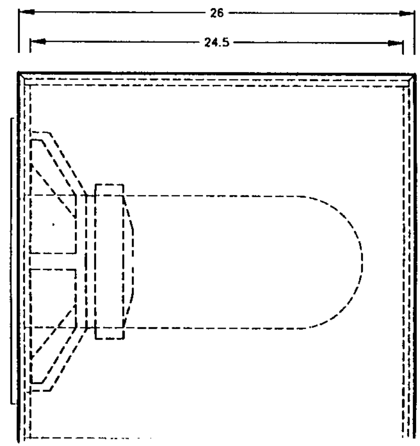
5. USE OF ALIPHATIC RESIN WOOD GLUE IS STRONGLY RECOMMENDED.

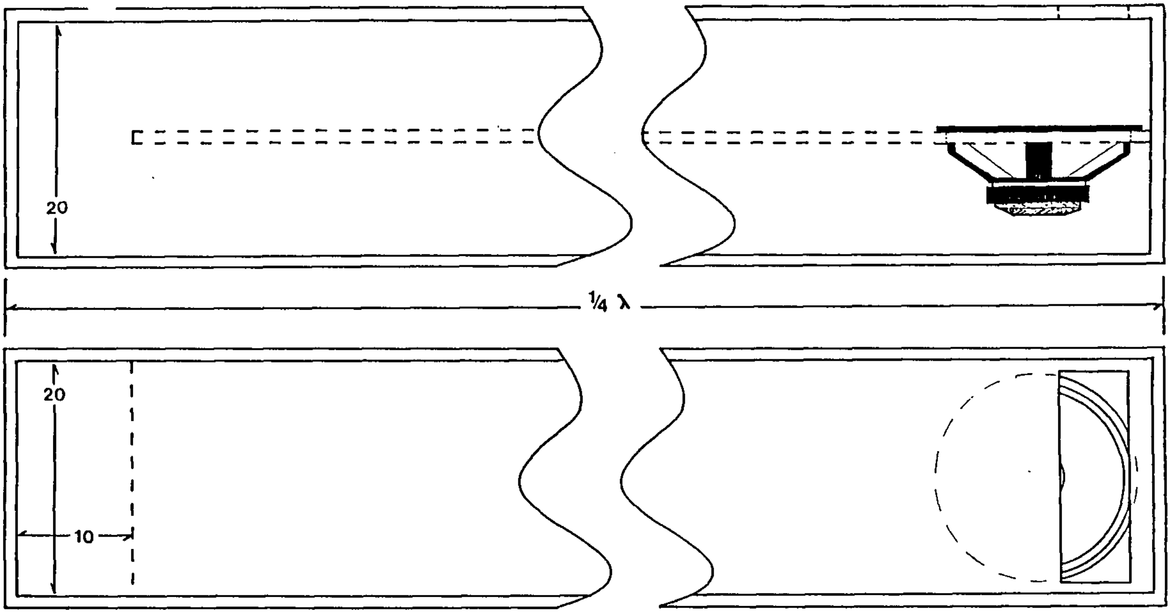
6. DUCT TUBE LENGTH (22 INCHES) IS MEASURED THROUGH CENTER FOR NON-ASSISTED 25 Hz BOX TUNING OR IS MEASURED THROUGH INSIDE OF BEND FOR 6th-ORDER (FILTER ASSISTED) 20 Hz BOX TUNING USING A HIGH-PASS FILTER WITH 20 Hz CENTER FREQUENCY AND A "Q" OF 2.0

7. SECURE CHICKEN WIRE TO INSIDE END OF DUCT TUBE TO PREVENT SMALL ANIMALS OR PETS FROM BEING TRAPPED INSIDE ENCLOSURE.

8. ADJUST OUTER BOX DIMENSIONS FOR MATERIAL THICKNESS USED. MATERIAL SHOWN IS 3/4", WHICH, WHEN PROPERLY BRACED, SHOULD BE ADEQUATE TO PREVENT ANY PANEL VIBRATION WHICH MAY WASTE ENERGY AND CAUSE ABBERANT FREQUENCY RESPONSE FROM THE SYSTEM.







NOTES: The air coupler is essentially an organ pipe driven by a loudspeaker. Its strong suit is producing high output near a single center frequency and the octaves immediately above and below that frequency. Output level and output bandwidth are inversely proportional and are controlled by varying the opening size. Larger openings yield greater output level but narrower bandwidth, while smaller openings give somewhat wider bandwidth at the expense of output level. The opening shown is 6 x 18 inches. Some experimentation will be needed when any driver or box length changes are made. A sliding port cover for the opening can be used to ascertain best system tuning. Box length depends on the desired center frequency, where gr[illegible]test output occurs, and is given by the [illegible]la: Box Le[illegible] = 282/frequency. The finished box sho[illegible] be made very rigid and free of air leaks. The JBL 22[illegible] is recommended as the driver for the Air Coupler. Reference: [illegible]

NOTES ON 70-VOLT AND DISTRIBUTED SYSTEM PRESENTATION
by Drew Daniels
NSCA, SEPTEMBER 10, 1985

The so-called 70 volt line distributed loudspeaker system wiring scheme offers a flexible means of operating multiple loudspeakers connected to singular amplifier lines.

The definition of the "70 volt" system is one in which 70 volts (70.7 volts) represents the maximum operating VOLTAGE delivered from the driving amplifier, regardless of the particular power level capability of that amplifier. A "70 volt" speaker transformer with power level taps of 1, 2, and 4 watts, will draw 1, 2, or 4 watts, depending on the tap selection, when the line voltage fed to the transformer's primary reaches 70.7 volts.

The 70 volt and other constant voltage (e.g. 25 volt, 50 volt, 140 volt) systems were devised to provide an economical means of driving many speakers over long signal lines with low loss. Higher voltage on the line allows use of less current in the wire, which in turn causes less voltage drop and power loss in the wire itself and allows use of smaller less expensive wiring.

It is not necessary to achieve 70 volts in the speaker lines to successfully operate a 70 volt system, but following the same logic that applies to any amp and speaker combination, the square of the voltage divided by the number of ohms representing the total system load will determine how much power will actually be distributed through the system.

An analogy of distributed system operation can be made from everyday house wiring to illustrate how a distributed system works: in a house there is an electrical conduit carrying 120 volts all over the house to wall outlets. A 20-amp circuit breaker feeds the line. At any outlet you can plug in a lamp to give you as much light as you need in that particular location, however, since the line is supplied by a 20 amp breaker, you can only plug in 2400 watts (120 volts X 20 amps) of total load before you run out of power and trip the circuit breaker. You can use twenty-four 100-watt lamps or fourty-eight 50-watt lamps or a hundred 24-watt lamps and so on, to use all of the available power, but you might also only use one lamp in each room drawing only a few hundred total watts, which will leave power to spare. The distributed system is a constant voltage system.

An amplifier capable of developing 70 volts into a load of 8 ohms can be used to provide 600 watts in a 70 volt system. This much power might be used to drive 200 ceiling speakers each with their transformer taps set to 3 watts, or half of all the speakers set to 4 watts and half set to 2 watts to create a loud zone-quiet zone arrangement where the two zones differ in sound level by 3 dB (3 dB is half/twice power and a just noticeable difference in speech sound level).

Substituting an amplifier with a maximum 50-volt / 4-ohm (600 watts) load capability rating and doing nothing else, would drop the available power to this system to 300 watts and provide each speaker in the system with half the power indicated by its transformer tap setting. Since this substitute amplifier is rated to drive a 4-ohm load where the original amplifier was rated at 8 ohms, another 200 speakers--a doubling of the original number--could be added to the system and would be driven at the same power level as the original 200 units, or half the rated tap setting value, allowing the full 600 watt potential of the substitute amplifier to be realized.

The Ohm's Law-based equations provide an easy way to determine just how much voltage, current or power is involved in particular system designs or what the total loading on a distributed line will be based on the wattage taps used and number of speakers connected to the line. JBL tech note, Volume 1, Number 2: "70-volt Distribution Systems Using JBL Industrial Series Loudspeakers," gives tables and other valuable information to aid in distributed system design.

Loudspeaker sensitivity and impedance rating play a big part in overall system efficiency. Speakers of different impedances draw different amounts of power from a constant voltage (e.g. the 70 volt system) source. For example, let's use two commercially available speakers, A and B. The pertinent specifications of the two devices are as follows:

SPEAKER A: Sensitivity = 97 dB SPL, 1 W, 1 m and impedance = 8 ohms.

SPEAKER B: Sensitivity = 86.5 dB SPL, 1W, 1m and impedance = 6 ohms.

Speaker transformers have insertion loss that is due mostly to resistive losses in the transformer, so the transformer loss itself can be calculated as if the loss element is a resistor. If we know that some typical transformer has one dB of insertion loss when working into its rated load impedance (usually 8 ohms), then we can calculate backwards and find the transformer's equivalent resistance to be 2 ohms. We know this from the fact that a transformer that has 1 dB of loss delivers 4 watts to a speaker when its 5-watt tap is used.

A speaker with lower impedance will draw more power from a constant voltage source, and if the source had negligible resistance itself, then the 4 watts available to the 8-ohm speaker A would become 5.3 watts but it's not quite that simple. If we place speaker A in a series circuit with our typical transformer, we find that the speaker drops 4 watts and the transformer drops 1 watt to make up the 5-watt total. The current across this combination is 0.707 ampere, which means the voltage drop across the 10-ohm load (8 ohms for the speaker and 2 ohms for the transformer's resistive loss) is 7.07 volts.

Substituting speaker B across the same constant voltage produces 0.884 ampere of current through the load (now 8 ohms total), and causes 1.56 watts to be lost in the transformer and 4.69 watts to be delivered to the speaker.

The difference between the 4.69 watts for speaker B and the 4 watts for speaker A is only a little over one-half dB. What might have seemed to be a potential advantage is eaten up by the transformer. and worse, the lower impedance speaker B is now pulling 6.25 watts from the line, which is 25% more power and will mean that you can only connect 80% of the number of speaker A you would have been able to connect to the line before you exceed the amplifier's available power.

The issue of speaker sensitivity is much more important when many speakers are used and the "dBs for dollars" problem can eat up profits quickly. Speaker A offers 97 dB SPL for 1 watt at the standard 1 meter distance. Speaker B offers 86.5 dB SPL for the same watt. This means that to achieve the same sound level at the same distance, speaker B will require more than 10 times more power than speaker A. Another way to look at it might be that it will require at least 3 times as many of speaker B to provide the same sound level as speaker A, and in some physical situations up to 10 times as many of speaker B.

OHM'S LAW-DERIVED EQUATIONS

TO FIND WATTS	TO FIND AMPS:
(volts squared) divided by ohms	volts divided by ohms
(amps squared) X ohms	watts divided by volts
volts X amps	square root of (watts divided by ohms)

TO FIND OHMS:	TO FIND VOLTS:
volts divided by amps	amps X ohms
(volts squared) divided by watts	watts divided by amps
watts divided by (amps squared)	square root of (watts X ohms)

JBL AMPLIFIER / AUTOFORMER OUTPUT CHARACTERISTICS

JBL Amplifier Model	Stereo Voltage Output	Bridged Voltage Output	Maximum Power/ Channel	Maximum Power/ Mono Bridge
6210/6211	17 VAC	-------	45 W	------
6215	17 VAC	27 VAC	45 W	90 W
6230	25 VAC	50 VAC	150 W	300 W
6260	35 VAC	70 VAC	300 W	600 W
6290	50 VAC	100 VAC	600 W	1200 W

JBL 70 volt[1] Autoformer/ Transformer #	Input Impedance	70 volt Output	Impedance Matching*	Impedance Ratio
6237	*4 ohms*	*150 W*	*6 ohms*	*1:9*
6267	*4 ohms*	*300 W*	*6 ohms*	*1:4*
6297	*4 ohms*	*600 W*	*8 ohms*	*1:2*
6218	4 ohms	45 W	112 ohms	1:28
6238	4 ohms	150 W	36 ohms	1:9
6268	4 ohms	300 W	16 ohms	1:4
6298	4 ohms	600 W	8 ohms	1:2

**can be used for step up or down.*

JBL AUTOFORMER/TRANSFORMER SPECIFICATIONS

Frequency Response : +,- 0.5 dB, 25 Hz to 20 kHz
THD : Less than 0.5 % , 25 Hz-20 kHz at rated power.
Insertion Loss : Less than 0.75 dB
Connections : Screw/Solder Lugs
Mounting : Mounting Brackets Attached

Model	Power	H	W	D	Weight	Shipping Weight
6237	150 W	4	3.25	3.5	7	8
6267	300 W	4.5	3.5	3.75	9	10
6297	600 W	4.5	3.75	3.75	10	11

[1] Italics indicate Autotransformer

BIBLIOGRAPHY of RECOMMENDED AUDIO REFERENCES

FOR AUDIO NOVICES:

BOOKS:

David B. Weems, "Building Speaker Enclosures," Radio Shack publication, stock# 62-2309

"The CAMEO Dictionary of Creative Audio Terms," Creative Audio & Music Electronics Organization, 10 Delmar Avenue, Framingham, MA 01701

F. Alton Everest, "The Complete Handbook of Public Address Sound Systems," Tab Books #966, Tab Books, Blue Ridge Summit, PA 17214

David B. Weems, "Designing, Building & Testing Your Own Speaker System," Tab Books #1364 (this is the same as the Weems book above)

Abraham B. Cohen, "Hi-Fi Loudspeakers and Enclosures," Hayden Book Co., 0721

Alex Badmaieff and Don Davis, "How to Build Speaker Enclosures," Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268

Bob Heil, "Practical Guide for Concert Sound," Sound Publishing Co., 156 East 37th Street, New York, NY 10016

PAPERS:

Drew Daniels, "The Most Commonly Asked Questions About Building Enclosures," JBL Professional, 8500 Balboa Blvd., Northridge CA, 91329

Drew Daniels, "Using the enclosure design flow chart," JBL Professional, 8500 Balboa Blvd., Northridge, CA 91329X

FOR EXPERIENCED AUDIO PRACTITIONERS AND HOBBYISTS:

BOOKS:

Jens Trampe Broch, "Acoustic Noise Measurement," Bruel & Kjaer Instruments, Inc., 185 Forest Street, Marlborough, MA 01752 (617) 481-7000

Howard M. Tremaine, "The Audio Cyclopedia," 2nd Edition 1969, Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268

Arnold P. Peterson and Ervin E. Gross, Jr., "Handbook of Noise Measurement," General Radio, 300 Baker Avenue, Concord, MA 01742

Martin Colloms, "High Performance Loudspeakers," A Halstead Press Book, 1978 John Wiley and Sons, New York and Toronto.

Harry F. Olson, "Modern Sound Reproduction," 1972, Van Nostrand Reinhold Co., New York.

Harry F. Olson, "Music Physics and Engineering," Dover Publications, 180 Varick Street, New York, NY 10014

Don and Carolyn Davis, "Sound System Engineering," Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268

F. Alton Everest, "Successful Sound System Operation," Tab Books #2606, Tab Books, Blue Ridge Summit, PA 17214

PAPERS:

Drew Daniels, "Notes on 70-volt and distributed system presentation," for the National Sound Contractors Association Convention, September 10, 1985, JBL Professional, 8500 Balboa Blvd., Northridge, CA 91329

Drew Daniels, "Thiele-Small Nuts and Bolts with Painless Math," presented at the 70th Convention of the Audio Engineering Society, November 1981 AES preprint number 1802(C8).

FOR ENGINEERS:

BOOKS:

Harry F. Olson, "Acoustical Engineering," D. Van Nostrand Co., Inc., 250 4th Street, New York 3, NY 1957 (out of print)

Leo L. Beranek, "Acoustics," Mc Graw-Hill Book Co., New York 1954.

Harry F. Olson, "Elements of Acoustical Engineering," D. Van Nostrand Co., Inc., 250 4th Street, New York 3, NY (1st ed., 1940, 2nd ed., 1947 -- both out of print)

Lawrence E. Kinsler and Austin R. Frey, "Fundamentals of Acoustics," John Wiley and Sons, New York and Toronto.

N.W. McLachlan, "Loudspeakers: Theory Performance, Testing and Design, Oxford Engineering Science Series, Oxford at The Clarendon Press 1934, Corrected Edition, Dover Publications 1960.

PAPERS:

Don B. Keele, Jr., "AWASP: An Acoustic Wave Analysis and Simulation Program," presented at the 60th AES Convention in Los Angeles, May 1978.

Fancher M. Murray, "An Application of Bob Smith's Phasing Plug," presented at the 61st AES Convention in New York, November 1978.

Don B. Keele Jr., "Automated Loudspeaker Polar Response Measurements Under Microcomputer Control," presented at the 65th AES Convention in London, February 1980.

R.H. Small, "Direct-Radiator Loudspeaker System Analysis," Journal of the Audio Engineering Society (JAES), Vol. 20, p. 383, June 1972.

Mark R. Gander, "Ground Plane Acoustic Measurement of Loudspeaker Systems," presented at the 66th AES Convention in Los Angeles, May 1980.

"Loudspeakers," An anthology of articles on loudspeakers from the pages of the Journal of the Audio Engineering Society, Vol. 1 through Vol. 25 (1953-1977). Available from the Audio Engineering Society, 60 East 42nd Street, New York, NY 10165 Telephone (212) 661-8528

A.N. Thiele, "Loudspeakers in Vented Boxes," Proceedings of the IREE Australia, Vol. 22, p. 487 August 1961; republished in the JAES, vol. 19, p. 382 May 1971 and p. 471 June 1971.

Fancher M. Murray, "The Motional Impedance of an Electro-Dynamic Loudspeaker," presented at the 98th Meeting of the Acoustical Society of America, November 19, 1979.

Mark R. Gander, "Moving-Coil Loudspeaker Topology As An Indicator of Linear Excursion Capability," presented at the 64th AES Convention in New York, November 1979.

Garry Margolis and John C. Young, "A Personal Calculator Program for Low Frequency Horn Design Using Thiele-Small Driver Parameters," presented at the 62nd AES Convention in Brussels, March 1979.

Garry Margolis and Richard H. Small, "Personal Calculator Programs for Approximate Vented-Box and Closed-Box Loudspeaker System Design," presented at the 66th AES Convention in Los Angeles, May 1980.

Fancher M. Murray and Howard M. Durbin, "Three Dimensional Diaphragm Suspensions for Compression Drivers," presented at the 63rd AES Convention in Los Angeles, March 1979.

R.H. Small, "Vented-Box Loudspeaker Systems," Journal of the Audio Engineering Society, Vol. 21,Z p. 363 June 1973, p. 438 July/August 1973, p. 549 September 1973, and p. 635 October 1973.

TECHNICAL NOTES INDEX

Technical Notes Vol. 2, No. 1A	1/3 Octave Equalization and the JBL/UREI 5547A and 5549A
Technical Notes Vol. 2, No. 2	JBL/UREI Power Amplifier Design Philosophy
Technical Notes Vol. 2, No. 3	Applications for the JBL/UREI 7922 Digital Audio Delay
Technical Note/Danger: Low Power	
Marketing White Paper	The Relationship Between the Sound Contractor and Religious Organizations

CONDENSED GLOSSARY OF AUDIO TERMS

by Drew Daniels

- A -

ABSORPTION
The ability of a material to absorb sound energy and reduce sound intensity by converting sound (vibration in air) to heat by means of friction in the material's structure (adiabatic heating).

ABSORPTION COEFFICIENT
The efficiency of a material to absorb sound at a particular frequency (which relates to sound wave length and material thickness). An absorption coefficient of 1.00 indicates total absorption, while a coefficient of 0.00 indicates total reflection. (see also, SABIN)

ACOUSTIC
Related to pressure changes or propagating mechanical waves in air or any other sound transmission medium, that comprise sound in its conventional form, as humans hear it.

ALNICO
An alloy of cobalt, nickel and aluminum used as permanent magnet material in magnetic structures of loudspeakers and microphones. In the early 1980's, alnico was largely supplanted in favor of ferrite in loudspeaker design because of political upheavals in the african countries that produce cobalt, the prime constituent of alnico.

AMBIENCE
The distinctive acoustical characteristic of a room or acoustic space due to the many sound reflections in the space. For example, rooms that are said to be acoustically "dead" lack ambience.

AMPERE
The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to $2X10^{-7}$ (0.0000002) newton per meter of length.

AMPLIFICATION
An increase in signal quantity of either amplitude or power level.

AMPLIFIER
A device which increases the voltage and/or power level of signals fed through it.

AMPLITUDE
The extreme range of a fluctuating quantity, as an alternating current, swing of a pendulum, etc., generally measured from the average or mean to the extreme.

ATTACK
The beginning of a sound or the initial transient of a musical note.

ATTENUATE
Reduce. In audio parlance, to reduce the level of an electrical signal as with a volume control, pot (potentiometer), fader or pad.

AUDIO FREQUENCY
Any frequency which humans hear, typically between a lower limit of about 12 hertz and an upper limit of about 20,000 hertz. This range of audio frequencies is also known as the "audio spectrum."

AUTOFORMER—AUTOTRANSFORMER
A single-winding coil, often on a magnetic core, resembling a transformer in physical appearance. When used for audio, the autoformer is fed a high-level signal such as that from a loudspeaker line, and produces desired changes in voltage at one or more taps along the coil's length. These taps are usually spaced so as to produce specific impedance ratios between inputs and outputs. For example, a 1:2 autoformer connected to an 8-ohm loudspeaker will convert its impedance to either 4 ohms or 16 ohms, depending on which way the connections are made.

AXIS
An imaginary center point. Looking down the center of a horn places the viewer "on axis" to the horn, while moving to the side so that the horn throat is not visible places the viewer "off axis."

- B -

BAFFLE—ACOUSTIC
An absorptive board or sound barricade that can be placed around or between acoustic sources to provide sound isolation or deadening and reduce acoustic leakage between multiple microphones, such as in a recording studio or live musical performance stage setup.

BAFFLE—SPEAKER
The enclosure surface, wall boundary or mounting board on which loudspeaker drivers are mounted.

BALANCED—BALANCED LINE
(see FLOATING)

BAND
In terms of audio frequency, a band is a portion of the audio frequency spectrum in the same way that green is a portion of the visible frequency spectrum. The audio frequency spectrum covers a range of over 10 octaves. The visible light frequency spectrum covers a range of less than 1 octave.

BAND PASS
A set of two filters that attenuate frequencies beyond the frequency limits of a given band of frequencies. The telephone, for example, is a band pass filter that eliminates low frequencies below about 300 hertz and high frequencies above about 5,000 hertz, causing the characteristic telephone sound most people are familiar with.

BAUD
The rate or frequency of data bit or byte transmission in a data transmission line.

BUS or BUSS
Like a bus that may carry many passengers, an audio bus is a wire or circuit that may carry more than one audio signal at a time.

- C -

CAPACITOR
An electronic circuit component part designed to store electricity. The value of such a part in farads (F) is a measure of the amount of electricity that can be stored. A theoretically ideal capacitor with a one-farad capacity is charged, from a discharged state, to a voltage of one volt, by applying a current of one ampere for a period of one second. Capacitors are made of two metal conductors separated by a non-conducting dielectric material such as paper, oil, glass, air, mylar, polypropylene, polystyrene, etc.

CARDIOID
Heart-shaped. Pronounced "car-dee-oid," in terms of microphones, refers to the relative sensitivity of the microphone with respect to the angle from which sound strikes the front (on-axis). Cardioid microphones decrease gradually in sensitivity as they are rotated away from the source of sound they are aimed at. Cardioids perform best if their off-axis frequency response is similar to their on-axis response.

CENTER FREQUENCY
The particular frequency at which the most boost or cut is available in a peak-dip type equalizer such as a graphic type, or a notch filter or parametric type.

CHANNEL
The individual audio signal path through a system which has more than one such path or as in the case of a single-channel amplifier a device which passes signals along only one electrical path.

CLIPPING
A distortion of audio signals caused by input signal peaks or voltage amplitudes which cause a circuit to attempt to exceed its own maximum voltage capabilities.

COMPRESSOR
An audio amplifier whose output amplification rate of change is less than its input signal amplitude rate of change. Compressors are used to reduce the dynamic range of program signal either to make everything sound louder, or to automatically control sudden large changes in signal amplitude as in the case of recording vocalists. Compressors sometimes include circuits that allow the user to adjust the time it takes to start compressing (attack), to ease up on the compression (release), and also the input and output gain. (see also, LIMITER)

COMPRESSION DRIVER
A loudspeaker designed specifically to drive a horn, matching the horn's acoustic impedance to achieve higher efficiency.

CONDENSER
(see CAPACITOR)

CORNER FREQUENCY
The frequency that defines the lower or upper limit of an audio frequency band, and where the power level is half of that in the middle of the band or "center frequency."

COULOMB
The coulomb is the quantity of electricity transported in 1 second by the current of 1 ampere.

CROSSOVER—ACTIVE, or ELECTRONIC
An electronic device which filters and selectively amplifies frequencies, separating the frequencies into sections or bands, and routing them to outputs designed to drive power amplifiers and in turn, speakers. The frequencies filtered depend on the electrical value of the component parts in the circuits of the device, but not on the source or load impedances connected to the device, except in the case where the crossover is actually a

passive crossover designed for insertion in the medium-level signal lines of an audio system rather than in speaker lines.

CROSSOVER—PASSIVE, or HIGH-LEVEL
An electrical device composed of coils of wire (inductors) and electrical capacitors, that separates audio frequency bands by filtering action and routes them to different places (such as a woofer and a tweeter). The frequency of the crossover's action is determined by the value of the electronic components inside, and by the loudspeaker driver's impedance in ohms, which implies that replacing a 16-ohm driver in a particular system with an 8-ohm driver, will change the crossover frequency; in such a case, the frequency will rise an octave and the shape of the crossover frequency response slopes will be distorted.

CROSSTALK
The leakage between audio signal carrying channels, typically heard as bleed-over between left and right stereo speakers, or as leakage of high-frequency sound between busses or circuits in audio mixers, microphone cable snakes, and multiple circuit audio signal wiring. Crosstalk is often caused by the electrical coupling by capacitance between the metal traces on printed circuit boards or the proximity of conductors in mixer wiring harnesses.

CUE
Also called "foldback," cue is a portion of audio signal in a system which is diverted and used for pitch and tempo reference by musicians or for timing reference by voiceover announcers for jingle production and motion picture dialog replacement dubbing (as from monitor speakers or headphones). The term "cue" is also used to describe the circuits within an audio mixer unit or an audio system designed to provide this reference.

CUTOFF FREQUENCY
All audio systems are limited to a band of frequencies in which they can do useful work. The frequencies are defined as the corner frequencies of a filter. Since for example, an amplifier cannot reproduce infinitely high notes, it is a low-pass filter whose cutoff frequency is the point (in hertz) where it can no longer produce full-power output, and where the actual output power falls to half the midband power or 3 decibels below the reference full- power output at midband (-3 dB point).

DAMPING or DAMPING FACTOR

The difference or ratio of an amplifier's output impedance and the impedance of the driven load. For example, an amplifier whose output impedance is 0.8 ohm driving a speaker whose impedance is 8 ohms has a damping factor of 10, while an amplifier whose output impedance is 0.08 ohm driving an 8-ohm speaker gives a damping factor of 100. Inserting a speaker cable whose resistance is .08 ohms in series with an 8-ohm speaker and an amplifier with a .08-ohm output impedance lowers the overall system damping factor to 50 (8 divided by .16).

DECIBEL or dB

A comparison of two similar values, like apples vs. apples, oranges vs. oranges or volts vs. volts. A voltage doubling (or halving) produces a 6 dB increase (or decrease), and a power doubling (or halving) produces a 3 dB increase (or decrease). The amount of power increase required for us to hear a twice-as-loud increase is +10 dB. The amount of power decrease it takes for us to hear a half-as-loud decrease is -10 dB. Thus to produce sound twice as loud as that produced by a 100-watt amplifier would require a 1,000-watt amplifier.

The dB is a power ratio. Calculating dB for power is done by multiplying the difference between two numbers by 10 times the base-10 logarithm of the numerical ratio.
For example:

50 watts = $10\text{Log}_{10}(50/1)$ = 16.99 dBW or 16.99 dB above one watt.

Quantities that are calculated using $10\log_{10}$ are:

Watts	Energy level
Illuminance	Intensity level
Power level	Energy density level

Quantities that are not power ratios must be calculated using $10\log_{20}$ as the multiplier. These include:

Volts	Vibratory acceleration
Amperes	Vibratory velocity
Sound pressure level	Vibratory force

VOLTS	dBV	dBu	WATTS	dBm	dBW
.02449	-32.2	-30	.0001	-10	40
.03162	-30	-27.8	.001	0	-30
.07746	-22.2	-20	.002	3	-27
.1	-20	-17.8	.01	10	-20
.24495	-12.2	-10	.1	20	-10
.31623	-10	-7.8	1	30	0
.77459	-2.2	0	10	40	10
1.0	0	2.2	100	50	20
10.0	20	22.2	1000	60	30

There are several significant decibel variations used in audio:

dB	- used alone as reference for level changes.
dBV	- ratio of volts referred to one volt.
dBu	- ratio of volts referred to 0.7746 volt.
dBm	- ratio of watts referred to one milliwatt.
dBW	- ratio of watts referred to one watt.
dB SPL	- ratio of sound pressures referred to 20 micropascals.

NOTE: dBm should not be use to denote a voltage, since that implies that a specific load impedance is known. dBm improperly used where dBu should be used must, therefor, include a statement of circuit dependency on a 600-ohm load, since dBm and dBu are equal only if the 1 mW dBm reference is driving a 600-ohm load:

watts = volts²/ohms, ∴ 0.7746 volt² = 0.6/600 ohms = 0.001 watt

DECAY
The fading away of a musical note after its onset or attack. In acoustics, the time it takes for echoes and reverberation to fade away. The term "RT_{60}" is used to describe the reverberation time of a room or acoustical space under study when a period of time has elapsed after a calibrated noise excitation is stopped, until the reverberation in the room drops to a sound pressure level 60 dB below the reference level of the excitation. RT_{60} values of 5– 10 seconds are typical of large cathedrals, RT_{60} between 1–5 seconds are typical of churches or gymnasiums and RT_{60} values between .1 and 1 second are typical of recording studios.

DIAPHRAGM
The moving part of a loudspeaker, particularly compression drivers and tweeters. The part of a loudspeaker that actually pushes on the air causing air motion.

DIFFRACTION

The phenomenon of sound waves bending around objects which are small compared to the length of the waves (see WAVELENGTH). Objects such as posts tend not to affect bass sounds but will shadow higher pitches (frequencies) to the extent that listeners will not hear tweeters that are not visible from their listening position.

DISPERSION
The directional pattern of sound radiation from a loudspeaker. The dispersion of horns is controlled by the horn's mouth walls, the overall size of the mouth and the length of sound waves emanating from the mouth. Low frequency loudspeakers normally radiate omnidirectionally at low frequencies, gradually forming beams of sound as frequency rises and sound wavelength becomes a smaller fraction of the loudspeaker's diameter. (see WAVELENGTH)

DISTORTION
An alteration in the shape, voltage, phase, timing relationships and frequency response of an audio signal caused either intentionally or unintentionally by circuitry that is driven to overload, or by poorly designed audio components such as microphones, mixers, effects, crossovers, amplifiers or speakers which do not accurately reproduce signals fed through them. (see OVERLOAD)

DIRECTIVITY
Directivity is a measure of the output of loudspeakers or horns based on the included angle within which the sound pressure level drops no more than 6 dB (one-quarter power). For example, a horn which covers a horizontal angle of 90 degrees (a quarter circle) where the two 45 degree off-axis points are 6 dB quieter than the on-axis measurement is said to have a (horizontal) "Q" of four, because it directs sound from what would have been an omnidirectional radiator (the horn's driver) into a quarter circle. Vertical directivity is derived in the same manner as is horizontal directivity, but the two figures are usually printed as two separate pieces of information on horn specification sheets since most horns radiate into different horizontal and vertical angles. A horn whose output covers angles of 90 degrees both horizontally and vertically, or one-quarter of a sphere, is said to have a total Q of 4, and a DI (Directivity Index) of 6 dB, since the same acoustical power from an omnidirectional radiator, forced to radiate into a quarter-sphere, is 6 dB louder at the same distance from the source than it would be radiating omnidirectionally, producing four times the apparent acoustical power to an observer such as a measurement microphone.

DIVIDING NETWORK
(see CROSSOVER)

DOPPLER EFFECT
For sound in air, the Doppler Effect takes the form of a shift in pitch which is proportional to the speed of any movement between a sound source and a listener such as the shift in the whistle on a passing train or the bells on a passing ice cream truck. In the same manner, a loudspeaker cone reproducing bass frequencies with their attendant long cone excursions will add a vibrato to any high-frequency tones being simultaneously reproduced by the same cone. The vibrato's rate will be that of the frequency of the lower reproduced pitch or pitches, and the vibrato depth will depend on the particular pitches that are interacting and the amplitude of low-frequency cone excursions. This vibrato is also called Doppler distortion, and is cited as one of a number of compelling arguments in favor of multi-way speaker systems.

DRIVER
Another name for loudspeaker; the word "driver" is used by non-engineers to designate a compression driver like those used to drive horns for acoustic amplification and directional control of sound.

DRY
An audio signal or sound without reverberation. An audio signal or sound with reverb is called "wet."

DUCT or **DUCTED PORT**
A tube attached to a speaker enclosure to "tune" and define the lowest usable frequencies of the enclosure. Like a bottleneck, a duct produces one distinct tuned pitch determined by its size relative to enclosure size. Such tuning is virtually independent of the bass driver mounted in the box, but grossly affects performance both in terms of frequency response and distortion.

DYNAMIC RANGE
The difference, in decibels, between the loudest and the quietest passages in a musical or audio program. Also, the difference between the maximum signal level that can be produced under nominal operating distortion levels by an electronic circuit, and that circuit's obnoxious noise level (called the "noise floor").

DYNE (per square centimeter)
An obsolete term used to designate 0.1 pascal, or 74 dB SPL (Sound Pressure Level). Also a unit of pressure equal to 0.1 newton per square meter. (see SPL chart on last page)

ECHO
Any or all audibly discrete delayed sound images. In contrast, reverberation produces a wash of sound, with no discrete echoes.

ECHO BUSS
A typically dedicated audio channel within an audio mixing console, through which is routed signals intended to be sent or received to or from an echo or reverberation device such as an echo chamber.

EDDY CURRENT
Electrical currents caused in electrical conductors (metals) by the presence of magnetic field variations. These eddy currents in turn cause local magnetic fields which act counter to the fields producing them. Most electric power meters are eddy current motors which rotate in direct proportion to the amount of current (amperes) flowing through them. Loudspeakers and transformers are designed to avoid or take advantage of eddy currents to enhance performance.

EFFECTS
Effects devices can be broadly classified as anything that changes the sound of signals passing through them. In this sense, a distorted amplifier is an effects device, although effects are usually thought of as the product of one of the following:

limiter
expander
noise gate
VCO
envelope generator
digital delay
flanger
stresser
preamplifier
boom-box

filter
equalizer
parametric EQ
VCA
echo
digital reverb/echo
exciter
parametric limiter
octave divider

compressor
graphic EQ
tone control
envelope filter
reverb
phasor
de-esser
direct box
vocoder

EFFICIENCY
Generally, efficiency is the ratio of input and output. Efficiency is usually expressed in percent, thus a loudspeaker which produces 8 acoustic watts when fed 100 electrical watts is 8% efficient, this would represent quite a high efficiency for a cone type loudspeaker. Typical hi-fi speakers and studio monitors range between 0.01 percent and 2 percent efficiency in their ability to convert electrical watts to acoustical watts. Power amplifiers give typically 50 to 98 percent efficiency, converting 60 hertz A.C. line power into audio frequency A.C. power.

EIGHTH SPACE
One eighth of a sphere. An acoustic boundary condition where the corner of a room causes low-frequency radiation from a speaker to be folded onto itself three times; once from the floor and once from each wall, producing a 9 dB increase in sound pressure over what the source would measure if hung in free space away from reflecting surfaces.

ELECTRET
A permanently electrically polarized microphone diaphragm used in place of an external high voltage supply to allow condenser microphone operation by the variable capacitor method.

ELECTROMAGNET
A magnet formed by the presence of electrical current in a coil of wire. A loudspeaker's voice coil is an electromagnet which alternately attracts and repels the permanent magnet in which it is situated, in response to the alternating electrical input from a power amplifier.

ELECTRONIC CROSSOVER
(see CROSSOVER–ACTIVE, or ELECTRONIC)

ENCODE — ENCODED
Alteration of audio signals prior to recording on tape, discs or other recording media. The alteration usually consists of pre-equalizing the incoming audio signals so that media noise is unaltered but signals on the media contain more high frequency energy, and often compressing the incoming audio signal so that less dynamic range is required of the media to store the audio signals. Decoding is normally the exact reverse of the encode functions, allowing signals to be re-expanded by a greater amount than normal expansion of the intrinsic playback noise of the recording medium.

ENVELOPE
The trend of waveforms that forms a composite waveform that may contain all the frequencies and signal components, sidebands and interactions of the signals in the envelope.

EQUALIZATION or EQ
The intentional alteration of levels of portions of the audio frequency spectrum to fit the requirements of frequency response defined by a listener. Traditionally the term equalization was used to describe the replacement (always a boost) of energy lost as a result of long telephone line runs of wire, but today the term is used to describe any change in frequency response or spectral balance done intentionally by using any device which includes circuits that can produce these changes.

EQUALIZER
An electronic circuit or device that selectively increases or decreases gain as a function of frequency. An equalizer may boost or cut only, or may do both. It may be a fixed circuit such as the equalizer in a phonograph preamp that restores the frequency response of a phono cartridge's output to flat from the record's normal non-flat output, or the equalizer may be a sophisticated self-contained device that allows user adjustment of frequency selection or continuous frequency tuning, bandwidth or Q and amount of boost or cut (parametric equalizer).

ERASE HEAD
A magnetic tape head used to remove recorded signals from tape using a high-level, high frequency bias signal that is turned on when a tape recorder's record circuits are active.

EXPANDER
An electronic device that makes loud signals louder and quiet signals quieter, thus expanding the dynamic range of the original signals.

- F -

FADER
An electronic component such as a potentiometer, or a circuit such as a voltage-controlled amplifier, that varies the amplitude of all the audio signals passing through it. Faders can be physically linked to the user's control by straight line knobs as with linear faders, rotary knobs such as those on trim and monitor controls or by means of computer and digital-to-analog converters that supply the necessary control voltage to operate the voltage-controlled amplifier circuit comprising a VCA fader.

FARAD
The farad is the capacitance of a capacitor between the plates of which there appears a difference of potential of 1 volt when it is charged by a quantity of electricity equal to 1 coulomb.

FEEDBACK
A portion of a signal which is fed into the audio signal chain or signal-carrying circuits, either in-phase or out-of-phase with the main portion of the signal, causing a reduction or increase of signal level in the system or circuits. In acoustic situations with microphones and speakers near each other, in-phase or "positive" feedback causes the familiar howling sometimes heard when too much system gain leads to recirculating sound build-up between mic and speaker. In electronic situations such as amplifiers, out-of-phase or "negative" feedback is put to use in the amplifier's circuits to reduce distortion, and lower output impedances.

FERRITE
A mixture of ceramics, iron powders or oxides, barium or strontium carbonate or other elements such as rare earths, which is cast and sintered (heated) and used as magnetic material to make permanent magnets or transformer or inductor cores. Ferrite magnets are also known as "ceramic magnets."

FET
Field Effect Transistor. A special type of transistor noted for its very high input impedance and linear operation, as compared to common bipolar transistor types which have lower input impedances and require higher bias currents to operate. Field Effect Transistors exhibit some of the operating characteristics of vacuum tubes which suits them for applications where tubes may have been favored over bipolar transistors.

FIDELITY
As with the common definition of fidelity, true to (the original), the term is used to describe the accuracy of the reproduction of audio signals by audio devices and components usually as the sound ultimately heard from the sound system by the listener.

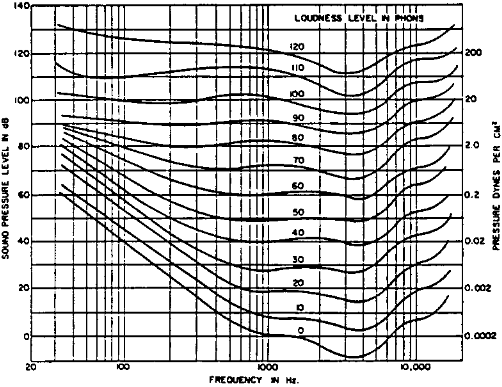
FIGURE EIGHT
The sensitivity vs. direction or angle pattern of a bipolar microphone or loudspeaker, as described on a rotating graphic level recorder chart by a pen responding to changes in level caused by the rotation of the device past a stationary sound source, or in the case of the bipolar speaker, a stationary measuring microphone.

FILTER
A circuit that selectively attenuates portions of the audio frequency spectrum. A filter is the opposite of the traditional equalizer, which selectively boosts, but for the purposes of modern convenient control of sound on mixers and equalizer units, the circuits of tone-altering controls usually incorporate the dual abilities to equalize and filter by simply rotating a knob one way or another.

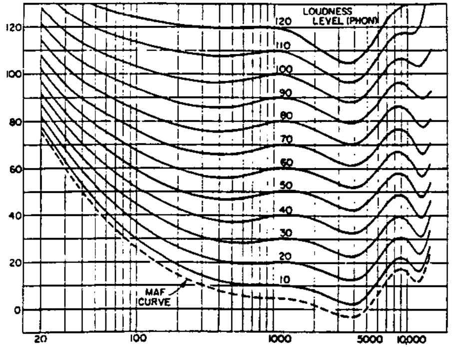
FLAT (Frequency Response)
The common term used to denote circuits, devices or audio systems that pass signals of different frequencies with equal amplitude over some range of frequencies (typically 20 hertz to 20 kHz for the audible range).

FLETCHER-MUNSON CURVES

One of several published sets of curves that graphically show how our ears perceive equal loudness for changes in frequency and for changes in sound level. Our ears are not flat and do not hear in a linear manner. At the normal threshold of hearing for humans (0 dB SPL or Sound Pressure Level), it takes some 10,000 times more acoustic power to enable us to hear a 20 hertz pure tone than it does to hear a 4000 hertz tone, while at 90 dB SPL, it requires only about twelve times more power to achieve the same relative perception of volume.



Fletcher-Munson curves (USA). (Courtesy, Acoustical Society of America)



Robinson and Dadson free-field equal loudness contours. Observer facing the source of sound.

FLOATING
A circuit which passes signals without reference to a ground. Typically, a floating audio circuit is characterized by a three-wire configuration called a "balanced line" where two wires carry the audio information and one wire acts as an electrostatic shield. The two shielded conductors of such a cable both carry equal voltage potentials of opposite polarity, from their driving source to their driven input, and so share a balanced voltage with respect to a neutral or imaginary reference. Electromagnetic radiation striking both signal carrying conductors at once is canceled by the input of the device being fed by virtue of the fact that the input circuit responds only to the differential voltage of the two signal carrying conductors, and the electromagnetic interference appears equally on both conductors, producing no differential voltage at the input. The reference wire or shield, may or may not be grounded, depending on ground loop currents that may be amplified causing hum in the system. Often, grounding is accomplished by mechanical connection of audio component chassis within a metal rack enclosure, in which case shielded wiring is unnecessary for balanced inputs and outputs.

Early telephone technology used transformer balanced inputs where a center tap of the transformer winding was grounded to dump electrostatic potentials. This type of wiring used an actual ground connection as the zero-voltage reference against which the two signal carrying conductors were balanced, thus enabling use of simple twisted pair, unshielded conductors for transmission of signals over long land lines where shielded cable would have proved prohibitively expensive but immunity to radio interference was required.

FLUTTER
Output amplitude variations from an audio reproducer such as a tape or record player due to one of several types of mechanically-based problems. Flutter may consist of simple amplitude modulations (AM) in output caused by rough tape handling or out-of-round idlers, or may take the form of frequency modulation (FM), small pitch variations, from bent or unevenly machined capstans or drive motors, pulleys or belts. AM components of flutter may also include tape modulation noise caused by uneven magnetic coatings or amplitude variations caused by loose magnetic oxide particles preventing good tape-to-head contact. FM components of flutter may also include scrape noise from tape-to-head, tape-to-tape guide or tape to flutter idler contact. Flutter is usually thought of as rapid variations of 10 hertz or more, and in fact, FM flutter components often extend up into the upper frequencies of the audio range. Very low frequency phenomena of a similar nature are called "wow," and are characterized by the 0.56 hertz pitch variations of 33-1/3 revolution/minute records with off-center spindle holes.

FOLDBACK
(see CUE)

FOLDED HORN
A horn whose internal path length is folded to produce a more compact package.

FREQUENCY
The spacing in time, of events. In audio signals, frequency refers to the cyclic repeat of vibrations. In wire, the vibrations are electrical variations. In air, the vibrations are changes in air pressure. The ear hears air pressure variations with frequencies between about 12 times per second and 20,000 times per second or 12 Hz (hertz) and 20 kHz (kilohertz).

FREQUENCY DIVIDING NETWORK
(see CROSSOVER)

FREQUENCY RESPONSE
A measurement of how a device being measured responds to test signals of constant amplitude without regard to frequency, over a particular measurement range of frequencies. An electrical device whose specifications say it is "flat from 20 Hz to 20 kHz," will not cause any amplitude deviation in signals fed through it over that frequency range, as a result of changing the frequency of the test signal.

FULL SPACE
A sphere. An acoustic condition where there are no boundaries to reflect sound. A sound source hung in free space away from reflecting surfaces does not exhibit the same bass boost as it would if set on the floor or against a wall. (see HALF SPACE and QUARTER SPACE)

FUNDAMENTAL
Any pure tone. The pitch remaining when all harmonics (overtones) are removed from a basic frequency or musical tone, producing a pure tone. An amplifier or audio circuit that can pass a pure tone without adding any harmonics of its own is said to have low harmonic distortion.
Musical instruments usually produce tones rich in harmonics, giving each its particular sound or "timbre." Small loudspeakers will be heard to reproduce bass instruments even while producing little or no fundamental pitch because the ear and brain reconstruct the sound of the instrument based on prior knowledge of its timbre.

- G -

GAIN
An increase. Amplifiers produce gain by increasing voltage and/or current. Horns produce acoustical gain by concentrating the sound of loudspeakers to narrower angles and frequency ranges. Gain is specified in decibels (dB), and while an amplifier may be used to produce unity gain, or a net increase of 0 dB in voltage, it may produce some current gain.

GAUSS

The obsolete term denoting a magnetic flux density of 0.0001 tesla. The SI unit, tesla (T) is equal to one weber per square meter. The weber (Wb) is the unit of magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of one volt as it is reduced to zero at a uniform rate in one second.

GROUND

In electronic equipment, ground is the zero voltage reference point in the circuitry. Ground is referred to as earth because true ground on power lines is provided by a heavy electrical conductor such as a copper bar, driven into the earth to make an electrical return path. This is why you become "connected" to ground when standing in water and are subject to shock from electrical equipment that is not also properly grounded.

GROUND LOOP

An electrical circuit where two or more paths to ground (true 0 volts) have different voltages as a result of current flow through wiring or chassis elements. The minute voltages on some ground legs may find their way into equipment input circuits and be amplified, causing hum, buzzing or in the worst case, inaudible high frequency oscillations, sometimes at high power levels, that can ultimately cause destruction of tweeter voice coils or even burn out amplifiers.

Ground loops are eliminated by tracing the small unwanted voltages with an oscilloscope to find and isolate their sources from other circuitry. Often, shields must be disconnected or chassis modified to prevent poor packaging designs from causing ground current flow. Sometimes, modifying internal wiring is the only thing that will eliminate a ground loop.

- H -

HAAS EFFECT

The effect of single strong echoes masking the real direction of sound sources. First described by Helmut Haas, the effect bears on our ability to discern sound source direction and understand speech consonants, in particular, when loudspeakers used for sound reinforcement produce sound arrivals before the original source (talker) or when these arrivals are too loud with respect to the original source.

HALF SPACE

One half of a sphere. An acoustic boundary condition where a surface causes low-frequency radiation from a speaker to be folded onto itself (the same acoustic power filling only half the amount of space), producing a 3 dB increase in sound pressure over what the source would measure if hung in free space away from reflecting surfaces.

HARMONIC DISTORTION
Distortion which is harmonically related to the fundamental signal fed through and audio circuit or system. Harmonic distortion is characterized by a harsh sound that ranges from a slight edge on some of the high-frequency components of a musical program, to the fuzz associated with electric guitar effects pedals.

HEADROOM
The reserve voltage or power level in an audio device or system. The difference in levels between the normal or "nominal" operating levels and the peak clean (undistorted) available levels. (see also NOMINAL OPERATING LEVEL)

HENRY
The henry is the inductance of a closed circuit in which an electromotive force of 1 volt is produced when the electric current in the circuit varies uniformly at a rate of 1 ampere per second.

HERTZ
The term hertz, abbreviated **Hz**, replaces the formerly used "cycles per second" or "cps." Named after Heinrich Hertz, the term applies to any regular, cyclic vibration or event. The term hertz always involves time (seconds) no matter what the period between repetitions of the event of interest; for example, a tone vibrating 1,000 times every second is said to be at a frequency of 1,000 hertz or 1 kilohertz (kHz). The earth spinning once around every day (86,400 seconds) rotates at a frequency of 11.6 microhertz (μHz).

HIGH CUT
(see LOW PASS)

HIGH PASS
A circuit or filter that stops low frequencies and passes high frequencies. A typical high pass filter use is protection of tweeters and compression drivers from the effects of over-excursion of their moving diaphragms. Low pass filters are used to attenuate or eliminate high frequencies from the drive to woofers so that they can operate in the frequency range where they are most linear (see LOW PASS).

HISS
The unwanted random noise associated with audio tape, unmodulated record grooves and noisy amplifiers and other audio circuitry. In circuitry, hiss is caused by the thermal activity of the molecules in the materials that electronic component parts are made of.

HYSTERESIS
The lag of effect or reaction after a stimulus as in the tendency of a magnet to resist being demagnetized or of a piece of iron to become magnetized after a magnetic field from a coil is introduced into it. Hysteresis in magnetic materials provides a means of measuring how well the material will function to provide a particular magnetic field in products such as loudspeakers. Magnetic materials such as alnico demagnetize and remagnetize easily, so care must be taken in the design of magnetic structures using alnico so that the magnetic source is protected from adverse magnetic fields like those produced by voice coils. Materials such as ferrites are innately difficult to magnetize and demagnetize, allowing more freedom in the design of magnetic structures without the same regard to adverse fields.

- I -

IEC
International Electrotechnical Commission. Also, the tape playback and record equalization standard specified by the IEC and used on many european analog tape recorders.

IEEE
Institute of Electrical and Electronic Engineers.

IHF
Institute of High Fidelity.

IM
Intermodulation Distortion. A form of distortion caused by two or more audio signal components that beat against each other to produce non-harmonically related pitches which do not sound musical because they are not part of tones or chords present in the original signal.

IMPEDANCE
The total amount of opposition to the flow of alternating currents in an electrical circuit which may comprise resistance, capacitance, inductance or reactance. Reactance is the imaginary part of impedance in the case where current and voltage are not in phase in an A.C. circuit due to the circuit's components and the frequency of the signal feeding through them. In such a case the impedance may be negative.

IMPEDANCE, load
The input impedance encountered by incoming signals from an audio circuit. The impedance presented by the load to a source or network.

IMPEDANCE, matching
The use of inputs and outputs whose impedance is equal, taking into account the effects of total circuit reactance on signals passing from output to input in order to produce minimum phase shift, optimum frequency response and optimum power transfer characteristics in the circuit. The DIN (Deutche Industrie Normen) standard adopted in West Germany, calls for all devices to have input impedances 100 times larger than the output impedances of devices driving them, specifically, 100 ohms output driving 10,000 ohms input impedance. The logic involved is that sufficiently low output or source impedances are "stiff" enough to swamp out impedance effects in subsequent circuits—to prevent the tail-wagging-the-dog symptom inherent in systems for which impedance matching is the only other solution.

IMPEDANCE, source
That output impedance which, when shunted by a resistor whose value in ohms is equal to it, loses half its original output voltage. The output impedance of most modern circuits such as solid-state amplifiers, chip or IC amplifiers and so on is nearly pure resistance because their circuitry is followed by buildout resistors to protect their solid state components thus allowing circuit design based on source resistance without regard to reactive impedance effects at the outputs of electronic devices. Power amplifiers, on the other hand, generally have very low source resistance and impedance. (see DAMPING)

INDUCTANCE
The term used to describe the electrical property of an inductor (coil or choke) in units of henrys (H), millihenrys (mH), microhenrys (μH), etc. A mechanical analogy of an inductor is an electrical spring; the inductor can store electrical energy fed into it and return it directly back into the circuit. The inductor tends to block the flow of A.C. currents depending on their frequency, and pass D.C. currents through.

INFINITE BAFFLE
A loudspeaker baffle that prevents the loudspeaker's rear radiation from entering the environment where the front radiation is being used. An infinite baffle may consist of either a wall extending out from the mounting surface of the loudspeaker such as when the loudspeaker is mounted in a hole cut in a wall, or a sealed enclosure filled with highly absorbent material such as fiberglass, for the purpose of soaking up the rear radiation.

INFRASONIC
Sound at frequencies generally considered to low to be heard (sounds in the range of 1 hertz to 15 hertz). Infrasonic sound can be felt if its power level is sufficiently high, and can cause nervousness and/or fatigue and disorientation in people exposed to it.

INPUT LEVEL
The level in units such as dB, volts or watts that a particular piece of electronic equipment receives at its input. Input levels are alternately described as nominal (the normal operating level) or maximum (the level above which distortion occurs). As an example, a piece of gear might have a meter marked " VU " and its specifications might say "nominal input: +4 dBu (1.228 volt), maximum input: +24 dBu (12.28 volts)." Feeding this piece of gear a 1.228 volt input signal should cause its meter to indicate 0 dB, and increasing the input voltage to 4 volts should make the meter indicate +10.2 dB when the unit's level controls are set to unity gain (see dB conversion table on page 7).

INSERTION LOSS
The loss in signal amplitude associated with passive electrical devices or circuit elements such as transformers, autoformers or passive high-level loudspeaker crossovers, that are inserted into the signal path of an electrical or electroacoustical system.

ISOLATION, acoustic
Refers to the attenuation of sound in adjacent acoustical spaces such as the isolation of the recording studio and control room by means of heavy double doors with air spaces and triple plate glass windows. The term is also applied to circuits in equipment such as mixers, in which isolation means the opposite of crosstalk.

- J -

JAN
Joint Army-Navy specification. Pertains to the stringent government specifications used for electronic components of specified quality or survivability or of tightly maintained quality control, and often means these parts will last longer, withstand higher temperatures, voltages, currents, etc., than their consumer counterparts.

JOULE
The joule is the work done when the point of application of 1 newton of force is displaced a distance of 1 meter in the direction of the force.

JUNCTION BOX
A box that provides cable terminations at jacks or connectors such as the XL-type microphone connections at the end of a multi-conductor microphone cable or "snake."

- K -

kHz
SI units abbreviation for kilohertz. One thousand cycles per second, or the repetition of an event, vibration or oscillation at a rate of one thousand per second. The term kHz replaces the obsoleted term kc (kilocycles).

KILO-
The standard SI prefix for thousands. The prefix kilo must always be spelled and abbreviated in lower case lettering. See SI for more information on standard units and prefixes and their use.

- L -

LCD
Liquid Crystal Display. Display composed of mobile crystals in liquid suspension, which align themselves and polarize light in response to a small electric change. The crystals are manufactured in pockets within the display which correspond to areas of dark on light background.

LEAKAGE
The unwanted pickup of stray sound from sources other than the intended source feeding a specific microphone channel.

LED
Light Emitting Diode. A solid-state diode rectifier whose atomic properties cause it to emit light when electric current is passed through it. Current LED technology allows the emission of light from infrared through green frequencies, and visible light LEDs are available in colors from deep red to green.

LEDE
Live End, Dead End. A listening room design technique used primarily in recording studio control rooms, where absorptive material is placed near the loudspeakers and reflective material is placed behind the listener.

LEVEL
The amount of power present at some point in an audio system. Specifically, the term level refers to the power magnitude in either electrical watts or acoustic watts but is often incorrectly used to denote voltage. (see also POWER and SPL)

LEVELING AMPLIFIER
An alternate term for "compressor" or "limiter."

LIMITER
An audio amplifier whose output amplification rate of change is less than its input signal amplitude rate of change. While compressors are used to reduce the dynamic range of program signal either to make everything sound louder, or to automatically control sudden large changes in signal amplitude such as in the case of recording vocalists, limiters are used to prevent dynamic transient signal peaks from exceeding a pre set amplitude. Limiters are usually required when broadcast signals are fed to telephone lines, and are useful to prevent power amplifier clipping and overdriving in large sound systems. Limiters sometimes include circuits that allow the user to adjust the time it takes to start reducing the signal amplitude (attack), to ease up on the compression (release), and also the input and output gain. (see also, COMPRESSOR)

LINEAR
When the output of a device tracks its input accurately, it is said to be linear. In the case of audio equipment, the output would be directly proportional to the input.

LINE LEVEL
The average (power) level at which signal-carrying wires operate. In audio systems, operating "levels" are usually divided into three categories.

Mic level:	-90 dBm (one picowatt) to -30 dBm (one microwatt).
Line level:	-30 dBm (one microwatt) to +30 dBm (one watt).
Speaker level:	line level or higher (audible from loudspeaker).

Typical levels that might correspond to a "0 VU" meter reading for these three categories are 2.45 millivolts (-50 dBu) for microphones, 316 millivolts (-10 dBV) or 1.23 volts (+4 dBu) for mixers, tape decks and signal processing equipment, and up to 70.7 volts (+37 dBV) for loudspeakers.

LINE OUT or **LINE OUTPUT**
An audio equipment output that supplies signals whose average magnitude is line level, between about 10 millivolts and 25 volts.

LINE RADIATOR
Usually, a speaker system in the form of a column of similar individual loudspeakers. Column speakers exhibit the same horizontal dispersion as a single loudspeaker element within the column, but narrower vertical dispersion due to sound wavelengths and the vertical dimension of the column. (see WAVELENGTH)

LOUDNESS
Sound volume as it is detected by the average human ear. Hearing is non-flat, and this non-flatness varies with changes in absolute SPL (Sound Pressure Level). The chart on page 14 shows curves of equal loudness for various absolute SPLs.

LOUDSPEAKER
A device for making audible sound waves, typically, an electroacoustic transducer that converts alternating current electrical oscillations fed to it, into acoustic oscillations (sound). The term "driver" is often used to denote individual loudspeakers within a speaker system, while the term "speaker" is often used to refer to the entire system comprising driver(s), enclosure and crossover.

LOW CUT
(see HIGH PASS)

LOW PASS
A circuit or filter that stops high frequencies and passes low frequencies. A typical low pass filter use is the hiss or scratch filter found on many preamplifiers or receivers to reduce static or record scratch noise, which is predominantly high frequency noise the ear is quite sensitive to. Low pass filters are used to attenuate or eliminate high frequencies from the drive to woofers so that they can operate in the frequency range where they are most linear.

MASKING

Masking is sound applied to an engineered environment to provide privacy in open office areas. The term "masking" refers to the so-called "cocktail-party effect" where certain conversations are hard to pick out because similar sounds mask them. The ear-brain can be fooled into not hearing certain sounds if other sounds at lower volume but sufficient complexity are simultaneously present. Pink noise is most often used to cause intentional masking; its spectrum is shaped or filtered and fed to loudspeakers hidden above an acoustical tile ceiling.

MICROBAR

A deprecated term for one millionth of a bar, the unit of atmospheric pressure replaced by the SI unit, the pascal (Pa). Atmospheric pressure at sea level reads 1,010,300 microbars, 101.3 kPa (kilopascals), or 101,300 pascals. In terms of sound pressure level, the pascal represents 94 decibels, and the microbar represents 74 decibels. (see PASCAL, see also SPL chart on last page)

MICROPHONE

An electroacoustic transducer which produces alternating current electrical signals proportional to sound signals to which it is exposed. Microphones are usually grouped into categories according to their directional sensitivity characteristics, their means of producing electrical signals, or the type of sound field they respond to i.e., some microphones respond to changes in air particle density (pressure microphones) and some to air particle motion (velocity microphones). Combinations of pressure, velocity or phase sensitivity can be employed in the design of microphones to yield nearly any desired pickup pattern.

MONAURAL

Having one ear. Monaural headsets (with a single earpiece) are typically used by telephone operators, stage managers and disco operators.

MONITOR

A device used as a reference for determining the integrity or quality of original program signals. Television monitors seldom have tuners or other extras, are adjusted for neutral color rendition (true color) and must have bandwidth (resolution) capabilities greater than the signals they are intended to display. Monitor speakers, like video monitors, should exhibit bandwidth that extends beyond the intended signal bandwidth, should be free of sound coloration and should have adequate resolution (accuracy) to make any faults such as ticks or hum audible to the operator. The dynamic range of both our eyes and ears, far exceed the capabilities of monitor devices to display or produce accurate facsimiles of life, so monitor use should include thoughtful adjustment of dynamics to make visual or sound images fit the capabilities of the monitor. These take the form of volume level adjustment for monitor speakers and brightness and contrast range adjustment for video monitors.

MONOPHONIC or MONO
Sound from one source, such as a single loudspeaker or earphone.

MULTI-MICROPHONE MONO
As used in multitrack recording of popular music, single microphone mono sounds are recorded onto various tape channels and then mixed together, using pan pots to adjust the left-to-right panoramic image position of each channel to create an impression of stereo sound when the final two-channel (stereo) program product is heard through headphones or stereo speakers.

MYLAR
Registered trade name of a particular polyester plastic manufactured by E.I. DuPont DeNemours Chemicals, Inc. Some of the many uses of Mylar include backing for recording tape, winding film for electric capacitors, and professional-use drum heads.

- N -

NAB
National Association of Broadcasters.

NANO-
The internationally used (SI) unit prefix designating divide by one billion or multiply by one billionth (10^{-9} or 1/1,000,000,000). The nano prefix is always written in lower case and always abbreviated simply by the letter n. Such prefixes are written with units such as meters (nm) or watts (nW) with no space between prefix and unit, but a single space after the numerical descriptor. The terms "250 nanowebers per meter" would therefore be written, 250 nWb/m.

NANOWEBER
One billionth (10^{-9} or 0.000000001) of a weber. The weber is the SI unit of magnetic flux. (see WEBER)

NEWTON
The newton is that force which gives to a mass of 1 kilogram an acceleration of 1 meter per second per second.

NOISE
Any unstructured and generally unwanted signal. Hum, buzz, hiss, crosstalk and rumble are typically classed as noise.

Random noise, as the name suggests, is noise consisting of random frequencies with random time and amplitude characteristics.

White noise is random noise whose various frequency components all share the same energy density characteristics, producing the same voltage at any particular discrete frequency over a period of time, thus causing a frequency response trend that rises the same number of decibels as the percentage of frequency increase. The 10 dB per decade of frequency (ten times power for ten times frequency) or 3 dB per octave of frequency (doubling of power for a doubling of frequency) is indicative of how many more discrete frequencies are crammed together in the same percentage of bandwidth spacing as frequency rises.

Pink noise is filtered white noise that exhibits a constant power in any band of frequencies of the same span percentage. For example the octave between 20 and 40 hertz contains only 20 hertz, while the octave between 2000 and 4000 hertz contains 2000 hertz. These two bands exhibit the same pink noise power, while the 2000–4000 hertz band would exhibit 100 times as much power if it were simply unfiltered white noise. Pink noise is used extensively as an audio measurement signal source because of its uniform power-per-bandwidth characteristic, and it has been suggested that music source material, averaged over a long time period, is roughly equivalent to pink noise in spectral energy distribution.

NOISE FLOOR
The intrinsic noise of an electronic device or system. The noise that remains in the absence of signal.

NOISE GATE
A circuit that attenuates or shuts off audio signals that fall below a threshold, usually set by the user. Noise gates are used to eliminate background hiss in sound systems and motion picture soundtrack restoration or low-level microphone leakage in multitrack, multi-microphone recording, etc.

NOMINAL OPERATING LEVEL
The design target signal level of audio circuits. For example, a crossover may have a noise floor of -80 dBu and a maximum output voltage of +24 dBu and call for a nominal operating level of +4 dBu which means that the nominal signal level will be 84 dB higher than the noise and allow for 20 dB of headroom.

- O -

OCTAVE
A doubling or halving of frequency. The numerical interval, for example, between 440 Hz and 880 Hz or 220 Hz is an octave.

OFF AXIS
(see AXIS, see POLAR PATTERN or POLAR RESPONSE)

OHM
The ohm is the electric resistance between two points of a conductor when a constant difference of potential of 1 volt, applied between these two points, produces in this conductor a current of 1 ampere, this conductor not being the source of any electromotive force.

OHM'S LAW
Physicist Georg Simon Ohm (1789–1854) described the relationship between electric current and resistance. Ohm's law states that the steady current through certain electrical circuits is directly proportional to the applied electromotive force, or, I=E/R where I is current, E is voltage and R is resistance. Equations solving for volts amperes and watts are derived from Ohm's basic equation. When calculating these quantities for A.C. circuits, the phase angle of the currents in the circuit must also be considered.

OMNI-DIRECTIONAL
Every direction. Omni-directional loudspeakers direct sound equally at all angles. Omni-directional microphones have equal sensitivity to sound coming from any angle.

OSCILLATOR
A device that oscillates. Sound is the oscillation of air caused by a mechanical oscillation such as that from a moving piano string or drum head. An electronic oscillator is a device containing circuits designed to produce electrical oscillations that are maintained, usually at a constant amplitude, and may have other specific characteristics, that suit them for use as circuit test signals.

OSCILLOSCOPE
An electronic test instrument which produces a visible image of electrical signals such as oscillations or waveforms, on a viewing screen.

OVERLOAD
The condition in which equipment is stressed beyond its normal operating limits. For sound equipment, overload may take the form of clipping in circuits, overheating of amplifiers, burning of loudspeaker voice coils, or loss of circuit integrity or breakdown. Overload may also be thought of as system operation at levels higher than the levels at which operation is linear, the overload condition producing non-linear circuit or system behavior, such as distortion. (see DISTORTION)

PAN or PAN POT
A two-circuit volume control used to place the auditory image of a sound from a mixer channel between the left and right speakers.

PASCAL
The SI unit of pressure, abbreviated Pa and defined as a pressure of 1 newton per square meter. In terms of sound it is convenient to imagine air in a balloon where the pressure is equal on the inside surface. An air pressure oscillation of one pascal R.M.S. produces a sound pressure level of 94 decibels referred to the threshold of hearing at 20 micropascals (20 μPa), and is roughly equivalent to 2.2 watts per square meter or about 100 nanowatts (10^{-9} or 0.0000001 watt) of acoustic power on human eardrums.

PASSBAND
The range of frequencies, within the -3 dB limits at the ends of the range. The "audio passband," for example, of a loudspeaker, would be the loudspeaker's frequency range within its -3 dB lower and upper frequency limits.

PASSIVE NETWORK
(see CROSSOVER)

PASSIVE RADIATOR
The passive radiator or "drone cone" is a movable mass, suspended over an opening in a speaker enclosure where it is free to resonate. The principle of operation of the passive radiator is a simple substitute for an air mass in a duct that would otherwise be too large to fit into the enclosure.

PHASE PLUG
An acoustical transformer and filter consisting of a mechanical channel or set of channels that guide sound from the moving diaphragm of a compression loudspeaker, to the exit throat of the loudspeaker. The phase plug is designed to match the diaphragm's acoustical impedance to that of a horn, and to adjust the sound path length from various areas of the diaphragm to the exit throat to maintain uniform phase. Generally, the more nearly equal are the sound paths through the phase plug from diaphragm to throat, the better the high-frequency response of the loudspeaker.

PINK NOISE
(see NOISE)

POLAR PATTERN or POLAR RESPONSE
The magnitude of output as a function of off-axis angle for speakers, or the sensitivity as a function of off-axis angle for microphones. Typically, the device (microphone or speaker) is "normalized" on-axis, that is, the on-axis

level is regarded as the 0 db reference and all measurements made off-axis then produce negative dB numbers. A horn said to have a polar pattern of 90 degrees, therefore, is one whose output level is -6 dB referred to its on-axis level, when measured 45 degrees off-axis.

POWER
Power is the conversion of energy to work. The unit of power is the watt (W). When complex signals such as music (time and voltage varying) are measured, a value for watts is derived by the use of R.M.S. (Root Mean Square) voltage divided by the load impedance to describe the amount of energy.

POWER BANDWIDTH
The frequency range over which a power amplifier can produce at least half power (-3 dB). This important specification is the actual indication of an amplifier's true power output capability, since many amplifiers are capable of much higher power outputs if frequency extremes such as those produced by music are ignored.

POWER RESPONSE
Like frequency response, power response is a measure of a loudspeaker's output with reference to its electrical input. Power response, however, includes the total sound energy radiated into the acoustic space around the loudspeaker rather than just on-axis. Flat power response, therefore, would indicate that a loudspeaker is radiating equal energy into all angles at all frequencies.

- Q -

Q
The term "Q" refers to the width of an effect. For example, a filter's Q is a measure of the frequency of the filter divided by the number of hertz contained within the band of frequencies bounded by the -3 dB points, thus an EQ filter at 1 kHz with a Q of 2 is 500 hertz wide at the -3 dB points. The Q factor of a horn is a measure of what part of a spherical pattern the horn radiates into (the beamwidth), therefore, where an omnidirectional source has a Q of 1 and the source placed on a reflecting surface has a Q of 2, a horn whose pattern is 90 by 90 degrees (one-eighth of a sphere), would have a Q of 8.

QUARTER SPACE
One quarter of a sphere. An acoustic boundary condition where two surfaces of a room cause low-frequency radiation from a speaker to be folded onto itself twice; once from each surface, producing a 6 dB increase in sound pressure over what the source would measure if hung in free space away from reflecting surfaces.

REACTANCE
The electrical characteristic of inductors and of capacitors, opposing the flow of A.C. electricity. Reactance is measured in ohms and may be negative, producing what is called an "imaginary" part of an impedance. Loudspeakers, for example, can be highly reactive, and under certain circumstances with certain signals, can feed 50 amperes or more back into the power amplifier driving them.

REFLECTION
Like light from a mirror, sound bouncing from a wall or other surface reflects. The amount and angle of sound reflection depends on the type and size of the reflecting surface, and the frequency (wavelength) of the sound.

REFLEX ENCLOSURE
A loudspeaker enclosure which uses the resonance of its internal air volume to assist the loudspeaker's motion, reducing distortion at low frequencies and extending low-frequency bandwidth.

REFRACTION
The bending of waves. Sound waves bend when they encounter boundary edges or air of a different temperature.

REMANENCE
The magnetic flux remaining in a magnetized material after a saturating magnetic field is applied and then removed.

RESISTANCE
Resistance to the flow of electric current. (see OHM)

RESISTOR
An electrical component made to resist current flow.

RESONANCE
The natural vibration or oscillation of mechanical or electrical systems at specific frequencies that depend on qualities such as mass and springiness (mechanical systems) or capacitance and inductance (electrical systems).

REVERBERATION TIME (RT_{60})
The time it takes for all reflected sounds in a space to decay 60 dB after the exciting sound source is turned off.

- S -

SABIN
The unit of acoustical absorption, named after Wallace Sabine. The sabin is the total absorbtion of sound by a surface area of one square foot.

SENSITIVITY

For mixers and amplifiers, sensitivity refers to the amount of input required to drive the circuit to its rated output.

For loudspeakers, sensitivity refers to the sound pressure produced by a given input voltage or power.

For microphones, sensitivity refers to the amount of electrical output produced by incident sound at a given sound pressure.

SI UNITS

The SI units are used to derive units of measurement for all physical quantities and phenomena. There are seven basic SI "base units," these are:

NAME	SYMBOL	QUANTITY
ampere	A	electric current
candela	cd	luminous intensity
meter	m	length
kelvin	K	thermodynamic temperature
kilogram	kg	mass
mole	mol	amount of substance
second	s	time

The SI derived units and supplementary units are listed here with applicable derivative equations:

NAME	SYMBOL	QUANTITY	DERIVED BY:
coulomb	C	quantity of electricity	A·s
farad	F	capacitance	A·s/V
henry	H	inductance	V·s/A
hertz	Hz	frequency	s^{-}
joule	J	energy or work	N·m
lumen	lm	luminous flux	cd·sr
lux	lx	illuminance	lm/m^2
newton	N	force	$kg \cdot m/s^2$
ohm	Ω	electric resistance	V/A
pascal	Pa	pressure	N/m^2
radian	rad	plane angle	
steradian	sr	solid angle	
tesla	T	magnetic flux density	Wb/m^2
volt	V	potential difference	W/A
watt	W	power	J/s
weber	Wb	magnetic flux	V·s

FURTHER DERIVED UNITS:

NAME	SYMBOL	QUANTITY
ampere per meter	A/m	magnetic field strength
candela per square meter	cd/m^2	luminance
joule per kelvin	J/K	entropy
joule per kilogram kelvin	J/(kg·K)	specific heat capacity
kilogram per cubic meter	kg/m^3	mass density (density)
meter per second	m/s	speed, velocity
meter per second per second	m/s^2	acceleration
square meter	m^2	area
cubic meter	m^3	volume
square meter per second	m^2/s	kinematic viscosity
newton-second per square meter	$N{\cdot}s/m^2$	dynamic viscosity
1 per second	s^{-}	radioactivity
radian per second	rad/s	angular velocity
radian per second per second	rad/s^2	angular acceleration
volt per meter	V/m	electric field strength
watt per meter kelvin	W/(m·K)	thermal conductivity
watt per steradian	W/sr	radiant intensity

DEFINITIONS OF SI UNITS

The **ampere** is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to $2X10^{-7}$ newton per meter of length.

The **candela** is the luminous intensity, in the perpendicular direction, of a surface of 1/600,000 square meter of a blackbody at the temperature of freezing platinum under a pressure of 101,325 newtons per square meter.

The **coulomb** is the quantity of electricity transported in 1 second by the current of 1 ampere.

The **farad** is the capacitance of a capacitor between the plates of which there appears a difference of potential of 1 volt when it is charged by a quantity of electricity equal to 1 coulomb.

The **henry** is the inductance of a closed circuit in which an electromotive force of 1 volt is produced when the electric current in the circuit varies uniformly at a rate of 1 ampere per second.

The **joule** is the work done when the point of application of 1 newton is displaced a distance of 1 meter in the direction of the force.

The **kelvin**, the unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.

The **kilogram** is the unit of mass; it is equal to the mass of the international prototype of the kilogram. (The international prototype of the kilogram is a particular cylinder of platinum-iridium alloy which is preserved in a vault at Sevres, France, by the International Bureau of Weights and Measures.)

The **lumen** is the luminous flux emitted in a solid angle of 1 steradian by a uniform point source having an intensity of 1 candela.

The **meter** is the length equal to 1,650,763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels $2p_{10}$, and $5d_5$ of the krypton-86 atom.

The **mole** is the amount of substance of a system which contains as many elementary entities as there are carbon atoms in 12 grams of carbon 12. The elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles or specified groups of such particles.

The **newton** is that force which gives to a mass of 1 kilogram an acceleration of 1 meter per second per second.

The **ohm** is the electric resistance between two points of a conductor when a constant difference of potential of 1 volt, applied between these two points, produces in this conductor a current of 1 ampere, this conductor not being the source of any electromotive force.

The **radian** is the plane angle between two radii of a circle which cut off on the circumference an arc equal in length to the radius.

The **second** is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.

The **steradian** is the solid angle which, having its vertex in the center of a sphere, cuts off an area of the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.

The **volt** is the difference of electric potential between two points of a conducting wire carrying a constant current of 1 ampere, when the power dissipated between these points is equal to 1 watt.
The **watt** is the power which gives rise to the production of energy at the rate of 1 joule per second.

The **weber** is the magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of 1 volt as it is reduced to zero at a uniform rate in 1 second.

The **liter**, although not an SI derived unit, is used extensively to denote volume. Officially, the liter (l) is 1/1000 of a cubic meter.

SI PREFIXES

The names of multiples and submultiples of any SI unit are formed by application of the prefixes:

MULTIPLIER	PREFIX	SYMBOL	TIMES 1, IS EQUAL TO:
10^{18}	exa	E	1 000 000 000 000 000 000
10^{15}	peta	P	1 000 000 000 000 000
10^{12}	tera	T	1 000 000 000 000
10^{9}	giga	G	1 000 000 000
10^{6}	mega	M	1 000 000
10^{3}	kilo	k	1 000
10^{2}	hecto	h	100
10	deka	da	10
0	--	--	1 (unity)
10^{-1}	deci	d	.1
10^{-2}	centi	c	.01
10^{-3}	milli	m	.001
10^{-6}	micro	µ	.000 001
10^{-9}	nano	n	.000 000 001
10^{-12}	pico	p	.000 000 000 001
10^{-15}	femto	f	.000 000 000 000 001
10^{-18}	atto	a	.000 000 000 000 000 001

Some examples: ten-thousand grams is written; 10 kg, 20,000 cycles per second is written; 20 kHz, 10-million hertz is written; 10 MHz, and 250 billionths of a weber per meter of magnetic flux is written; 250 nWb/m.

Always use less than 1000 units with an SI prefix; "1000 MGS" is advertising hyperbole and should be written " 1 g " only.
SI prefixes and units should be written together and then set off by a space (single space in print) from their numerators. For example; use the form "35 mm " instead of " 35mm " and " 1 kHz " instead of " 1k Hz ."

When writing use standard SI formats and be consistent. You should consult National Bureau of Standards publication 330, (1977) for details on usage.

Never combine SI prefixes directly, that is, write 10^{-10} farads as 100 pF instead of 0.1 micro-microfarads (µµF). Keep in mind that whenever you write out a unit name longhand, the rule is that the name is all lower case, but when abbreviating, the first letter is upper case if the unit is named after a person and lower case if it is not; examples: V = volt for Volta, F = farad for Faraday, T = tesla for Tesla, and so on. Letter m = meter, s = second, rad = radian, l = liter and so on. Revolutions per minute may be written only as r/min, miles per hour may be written only as mi./hr., and inches per second may be written only as in./s and so on.

In addition to the correct upper and lower case, prefixes and combinations, there is also a conventional text spacing for SI units and abbreviations. Write 20 Hz, rather than 20Hz. Write 20 kHz, rather than 20k Hz, and so on. Always separate the numerator of a unit from its prefix and/or unit name, but do not separate the prefix and name. -dd

SUBSONIC
Below the speed of sound. (see also, INFRASONIC)

SUBWOOFER
Loudspeaker system designed to produce or reproduce only low frequency sounds, typically below 150 hertz.

SUPERSONIC
Faster than the speed of sound (approximately 344 meters or 1130 feet per second at sea level). (see ULTRASONIC)

- T -

TESLA
The SI unit of magnetic flux density, derived by webers per square meter.

THIELE or THIELE-SMALL ALIGNMENT
The use of mathematical simulation of speaker system low frequency operation by calculating the values of the electrical analogies of loudspeakers and enclosures.

TIMBRE
Characteristic sound. Timbre is formed and affected by the ratios of harmonics to their fundamental, allowing for the difference heard in the same pitch played on different instruments.

TIME DELAY SPECTROMETRY
Time Delay Spectrometry is a method of measuring audio signals by creating a measurement "time window" through which signals pass without concomitant obscuring noise.

TRANSDUCER
A device which converts one form of energy directly into to another form of energy. Loudspeakers, microphones and motors are transducers which convert motion into electricity or vice versa. Light-emitting diodes and solar cells are transducers that convert electricity to light or vice versa, etc.

TRANSFORMER
A device used to isolate or to raise or lower an A.C. voltage from its input to its output. A typical transformer may consist of two separate coils of wire wound on a magnetic steel core. When an A.C. current passes through the input coil (primary) it produces an alternating magnetic field in the core, which in turn produces current flow in the output coil (secondary). By winding a greater number of coil turns for the secondary winding, the input voltage is raised at the output; by using fewer secondary turns, the output voltage is lowered. An isolation transformer uses the same number of turns for primary and secondary, maintaining the same input voltage at the output while severing the electrical connection of the two coil windings.

TRANSIENT
A momentary amplitude peak in program source. A pop from a switch or scratched record may form signal transients. Musical transients occur as a result of such things as percussion instruments, piano and guitar. Normal musical transients my have amplitude peaks as high as 40 dB above the average program levels, requiring headroom in the circuits and equipment used to reproduce them.

TRANSIENT RESPONSE
The response of audio equipment to sudden large changes in signal amplitude, such as those produced by musical transients.

TUNED ENCLOSURE
A speaker enclosure designed to use its internal air volume to aid operation of a woofer installed in it. Reflex or bass-reflex enclosures are one form of tuned enclosures. Tuned pipe enclosures use their internal air volume as a resonating air column like an organ pipe, driven by the woofer.

TUNED PORT
The vent in a reflex enclosure which causes the air inside the enclosure to resonate at a particular frequency, obtained by adjusting the vent opening size. When ducts (tubes or tunnels) are added to vent openings, the tuned frequency is lowered, allowing the use of larger vent area openings to achieve the same tuning frequency.

TWEETER
A loudspeaker designed to reproduce high frequencies only. Tweeters are typically used at frequencies beyond the center of the audio spectrum, which, if placed on a logarithmic scale like a piano keyboard, would be about 630 Hz.

- U -

ULTRASONIC
Beyond the range of human hearing. (see SUPERSONIC)

UNBALANCED
Wiring consisting of two conductors, usually one inside the other with the outer conductor shielding the inner conductor. The outer shield is connected to ground or chassis and the inner conductor carries the signal. Virtually all hi-fi signal wiring is of the unbalanced type, as is wiring inside TV sets, audio mixers and other audio equipment. (see FLOATING)

UNITY GAIN
No gain or loss. A device with unity gain would produce the same voltage at its output as the voltage applied at its input.

- V -

VA
Volt-Ampere. Like watts, VA is used to describe the product of volts multiplied by amperes, but in circuits that exhibit reactance.

VCA
Voltage Controlled Amplifier. An amplifier whose gain can be controlled by varying an external D.C. voltage. Since this D.C. voltage is relatively simple for computers to provide, the inclusion of VCAs in mixers and mixing consoles simplifies remote control of volume levels or memorized mixing functions.

VOICE COIL
A coil of wire within a magnetic field in a loudspeaker, which produces magnetic fields in response to signals from audio power amplifiers. These fields cause the voice coil to move within the stationary magnetic field of the loudspeaker, moving the diaphragm attached to it and the air touching the diaphragm.

VOICING
The equalization of sounds produced by a system such as a piano or a loudspeaker so that the audio spectrum is produced evenly with all notes or frequencies at the same volume.

VOLUME
A popular term used to denote sound intensity level.

- W -

WATT
The watt is the power which gives rise to the production of energy at the rate of 1 joule per second. (see JOULE)

WAVELENGTH
The length of waves (from crest through trough to crest) produced by propagating sound, light or electromagnetic radiation. All radiation produces waves. Sound is the slowest propagating wave, traveling approximately 344 meters or 1130 feet per second. Thus sound waves produced by a 1000 Hz tone are about 0.344 m or 1.13 foot in length (1000 per second divided by 1000 = one cycle = one wavelength). Light and electromagnetic radiation in the vacuum of space travel at 299,792.4563 kilometers or about 186,282 miles per second. Visible light waves are on the order of 450 to 700 nanometers or 17 to 28 trillionths ($28X10^{-12}$ or 0.000000000028) of an inch in length.

WAVEFORM
The shape of the wave produced by a sound. Such shapes depend on the content of harmonics of the sound, and can be viewed on an oscilloscope fed by a microphone or other sound signal source.

WEBER
The weber is the SI unit of magnetic flux. The weber is abbreviated with upper case W, lower case b (Wb). The concept of flux can be tricky to state. The International General Conference on Weights and Measures used the following wording to define the weber: The weber is the magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of 1 volt as it is reduced to zero at a uniform rate in 1 second.

WET
The addition of reverberation to audio program source material makes the sound "wet" referred to "dry" sounds with no reverberation. (see DRY)

WHITE NOISE
(see NOISE)

WOOFER
A loudspeaker designed to reproduce low-frequency sound only. Some woofers are called full-range loudspeakers and are used alone e.g. ceiling speakers. Woofers in systems are usually used below about 3000 Hz.

- X -

XFMR
An abbreviation for "transformer."

XL or XLR CONNECTOR
Typically, a three-pin plug or receptacle with a metal shell, used for microphone cables and line level signal-carrying cabling.

R.M.S. Power/unit area		dB SPL	Pressure units conversion
		195	100 kPa 1 bar 1 atmosphere
10 MW/m^2	1 kW/cm^2	190	
		185	32 kPa
1 MW/m^2	100 W/cm^2	180	20.4 kPa
		175	10 kPa 100 mbar
100 kW/m^2	10 W/cm^2	170	1 lb/in^2 r.m.s.
		165	3.2 kPa 32 mbar
10 kW/m^2	1 W/cm^2	160	2.04 kPa
		155	1 kPa 10 mbar
1 kW/m^2	100 mW/cm^2	150	
		145	320 Pa
100 W/m^2	10 mW/cm^2	140	204 Pa
		135	100 Pa 1 mbar
10 W/m^2	1 mW/cm^2	130	
		125	32 Pa
1 W/m^2	100 µW/cm^2	120	20.4 Pa 204 µbar
		115	10 Pa 100 µbar
100 mW/m^2	10 µW/cm^2	110	--------------- 1 W/1 m free-field SPL of a 100% efficient source.
		105	3.2 Pa
10 mW/m^2	1 µW/cm^2	100	2 Pa
		95	1 pascal — 10 µbar — 10 dynes/cm^2
1 mW/m^2	100 nW/cm^2	90	
		85	320 mPa
100 µW/m^2	10 nW/cm^2	80	204 mPa
		75	100 mPa — 1 µbar — 1 dyne/cm^2
10 µW/m^2	1 nW/cm^2	70	
		65	32 mPa
1 µW/m^2	100 pW/cm^2	60	20.4 mPa
		55	10 mPa 100 nbar
100 nW/m^2	10 pW/cm^2	50	
		45	3.2 mPa
10 nW/m^2	1 pW/cm^2	40	2.04 mPa
		35	1 mPa 10 nbar
1 nW/m^2	100 fW/cm^2	30	
		25	320 µPa
100 pW/m^2	10 fW/cm^2	20	204 uPa
		15	100 µPa
10 pW/m^2	1 fW/cm^2	10	
		5	32 µPa
1 pW/m^2	100 aW/cm^2	0 dB SPL	— 20.4 µPa — .0002 µbar — .0002 dyne/cm^2

Note: the definition of 0 dB SPL is the pressure measured at a point on the surface of a square meter which is uniformly irradiated at a power level of 10^{-12} acoustic watts. The free-field pressure reading is a sample reading taken by a pickup at a specified distance from a sound source, where both the source and pickup are of negligible size with respect to the wavelengths of sound being measured.

A "Quick Start" Application Guide to the JBL/UREI 7110 Compressor/Limiter

Introduction

This card is designed as a general information guide for the beginning user of the 7110. The settings below should be used as guidelines and not as absolute rules. With experimentation you may find "magic" settings that can take you far beyond what is outlined here. When defining the level settings we will use the following icon to indicate the relative position of each control:
The **Output** level control should be adjusted as needed to obtain the best signal to noise ratio (consult Sections 2.8 and 3 of the 7110 Owners' Manual for more information). For additional information on the 7110 see the back of this card, or, for the most complete information, consult the 7110 Owners' Manual.

General Purpose Set Up

This is a good general purpose setting that is also useful in emergency setups. Engage the **Auto** button and adjust the **Threshold** control for the desired amount of compression. The **Detector**, **Attack**, **Release**, and **Ratio** front panel controls are disengaged and a program dependent circuit is engaged.

Vocals—Lead

1. A good beginning setting is to set the following controls to the indicated positions: **Detector** **Attack** **Release** and the **Ratio** control anywhere from **2:1** to **4:1** compression ratio. The **Threshold** control should be set to obtain only **4 dB** to **6 dB** of gain reduction. The **Auto** button should be disengaged.
2. For a "breathier" sound on the vocals, heavier compression is necessary. Set the **Detector** **Attack** **Release** or and the **Ratio** control to **6:1**. The **Auto** button should be disengaged. The **Threshold** control setting will depend on the singer and program material involved, but in most cases will be at least **8 dB** and sometimes as much as **20 dB** of gain reduction.

Vocals—Problem

Vocals that are thin, sibilant, or otherwise problematic may benefit from special processing of the **Detector** signal only. This setup is shown on the reverse side of this card under the heading "How to Create a Frequency Dependent Threshold with the 7110." Equalizer frequencies and control settings may vary greatly, so some experimentation will be necessary when creating this effect.

Vocals—Background

1. If a group of vocalists is having trouble blending together, try the settings described in Pt. 1 of Vocals—Lead above, but use one compressor (or two for stereo; see Section 3.5 on linking multiple limiters in the 7110 Owners' Manual) on the whole vocal ensemble as a group, not individually. This effect can work well for basic tracks, final mixdown and live performance.

Vocals—Background (Continued)

2. For "oohs" and "aahs" or other material that should have a "breathy" type of sound, use the settings described in Pt. 2 of Vocals—Lead.
3. For a special effect and/or assistance in mixing, the 7110 may be used as a "ducker" for mixing background vocals into a busy mix. To implement this effect, feed the entire mix (or any part you desire) except the background vocals through one or two (for stereo) 7110 compressors. Next, take a send from the background vocals mix and connect it to the **Detector** input of the 7110. Engage the **Auto** button for program dependent compression, then set the **Threshold** for **2 dB** to **6 dB** of gain reduction when the background vocalists are singing. Make sure the **Link** button is engaged if you are operating in stereo (see Section 3.5 in the 7110 Owners' Manual on linking multiple limiters). Now mix the background singers in with the rest of the band. Blending should now be easier, because every time the background vocalists sing, the band's volume will be reduced from 2 dB to 6 dB. This effect may take a couple of minutes to set up, but it can make a difficult mix easier to control. This effect may also be used on lead vocals. See "How to Create a Ducking Processor" on the other side of this card for additional information.

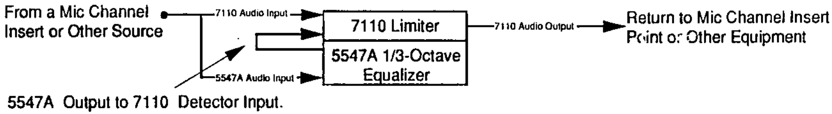
Bass Guitar

1. For a "funky" bass guitar sound, set the **Detector** **Attack** **Release** and **Ratio** to **4:1**. The **Auto** button should be disengaged. Set the **Threshold** to achieve at least **6 dB** of gain reduction; more gain reduction may be necessary in some cases. With this setting, the bass transient of the pluck will be accentuated and the sustain and decay should be close to normal. Some fine tuning of these settings may be desirable.
2. For a longer bass guitar sustain, increase the **Ratio** setting to **6:1**, set the **Threshold** to achieve **8 dB** or more gain reduction, set the **Release** and set the **Attack** to obtain the desired amount of bass transients.

Percussion

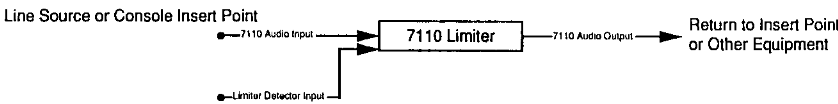
1. Tambourines and other percussive instruments with metallic sounds may have very high transient peaks that can be controlled with the following 7110 settings: **Detector** **Attack** **Release** **Ratio** set to anywhere from **10:1** to **20:1**. The **Auto** button should be disengaged.
2. A small of amount of compression used on the kick drum may help obtain a "tight" or "punchy" kick drum sound. Set the **Detector** **Attack** **Release** and **Ratio** from **2:1** to **4:1**, with the **Auto** button disengaged.

How to Create a Frequency Dependent Threshold with the 7110



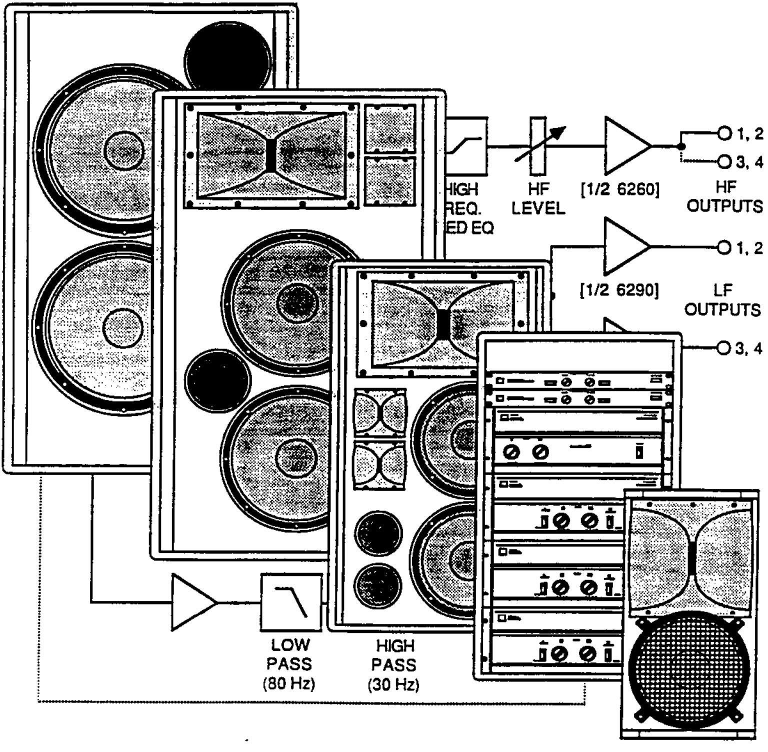
Above is a way in which the Detector input may be used to take the program signal, process it through some other device (such as an equalizer) and use that processed signal to drive the detector. One such application is known as a "de-esser." In this application the program signal is fed in parallel to the inputs of the 7110 and an equalizer which is set up to boost high frequencies above about 5 kHz. The output of the equalizer, returned through the Detector input, drives the gain reduction circuit. Because of the equalizer, the circuit has a frequency-dependent threshold which, in this case, is more sensitive to the presence of high frequency program material. Some talkers have an overabundance of high frequencies in their "esses," and this type of circuit may be used to improve the "listenability" of their speech. The Detector control should be set toward Peak, and the Attack and Release controls set to fast response.

How to Create a Ducking Processor



The above circuit allows the limiting action to be controlled by some other audio signal, instead of the signal being compressed. One example of this is known as "ducking." In this application the compressor is used to reduce the level of one signal whenever another "more important" signal is present. The example most used is that of an announcer talking over some other program material. The program material is normally passed through the compressor with little or no compression. But, whenever the announcer speaks, the compressor turns down the program material. The Threshold control, as always, sets the level for the threshold and, therefore, the amount by which the program material will be turned down. Careful adjustment of attack and release times is very important to avoid an overly processed sound. The exact adjustments will depend highly on the nature of the program material, and exactly how much "ducking" is desired. The detector control should be in the average position, since we are adjusting loudness.

In the world of creative music mixing, anything goes, and the detector input offers the capability to modify the sound in ways that are beyond the scope of this manual. Here is one example to get you started: drive the Detector input with a very low frequency sine wave signal. The audio program material can be made to rise and fall with the sine wave. Controls on the 7110 should probably be set for fast attack and release, high ratio and peak detection. This is called envelope detection.



Concert Series

Electronics and Complete Systems
Installation and Operating Instructions

Figure 1—Concert Series Complete Systems, Components and Accessories

System Model	Standard Equipment: Electronics Rack	Standard Equipment: Main Loud-speakers	Standard Equipment: VLF Loud-speakers	Standard Equipment: Speaker Cables	Optional Equipment: Electronics Road Case	Optional Equipment: Speaker Dollies
4921	9922	(2) 4850 (4852)	—	(2) 3850	9916RC	(2) 4850DL
4921T	9922T	(2) 4851 (4853)	—	(2) 3850	9916RC	(2) 4850DL
4922	9922	(2) 4870 (4872)	—	(2) 3850	9916RC	(2) 4870DL
4922T	9922T	(2) 4871 (4873)	—	(2) 3850	9916RC	(2) 4870DL
4923	9923	(2) 4870 (4872)	(2) 4845	(2) 3850 (2) 3805	9916RC	(4) 4870DL
4923T	9923T	(2) 4871 (4873)	(2) 4845	(2) 3850 (2) 3805	9916RC	(4) 4870DL
4924	9923	(2) 4850 (4852)	(2) 4845	(2) 3850 (2) 3805	9916RC	(2) 4850DL (2) 4870DL
4924T	9923T	(2) 4851 (4853)	(2) 4845	(2) 3850 (2) 3805	9916RC	(2) 4850DL (2) 4870DL
4925	9922	(2) 4825	—	(2) 3850	9916RC	—
4926	9922	(4) 4825	—	(2) 3850 (2) 3805	9916RC	—
4927	9942	(8) 4825	—	(4) 3850 (4) 3805	9916RC	—
4941	9942	(4) 4850 (4852)	—	(4) 3850	9916RC	(4) 4850DL
4941T	9942T	(4) 4851 (4853)	—	(4) 3850	9916RC	(4) 4850DL
4942	9942	(4) 4870 (4872)	—	(4) 3850	9916RC	(4) 4870DL
4942T	9942T	(4) 4871 (4873)	—	(4) 3850	9916RC	(4) 4870DL
4943	9943	(4) 4870 (4872)	(4) 4845	(4) 3850 (4) 3805	9920RC	(8) 4870DL
4943T	9943T	(4) 4871 (4873)	(4) 4845	(4) 3850 (4) 3805	9920RC	(8) 4870DL
4944	9943	(4) 4850 (4852)	(2) 4842	(4) 3850 (2) 3805	9920RC	(4) 4850DL (2) 4870DL
4944T	9943T	(4) 4851 (4853)	(2) 4842	(4) 3850 (2) 3805	9920RC	(4) 4850DL (2) 4870DL
4945	9923	(2) 4825	(2) 4845	(2) 3850 (2) 3805	9916RC	(2) 4870DL
4946	9943	(4) 4825	(2) 4842	(4) 3850 (2) 3805	9920RC	(2) 4870DL

Figure 2—Concert Series Amplification Systems and Components

System Model	Type	Power Amplifiers: VLF	Power Amplifiers: LF	Power Amplifiers: HF	Power Amplifiers: VHF	Signal Processing: Units	Signal Processing: high-pass	Signal Processing: crossover	Signal Processing: shelving
9922	2-Way	—	(1) 6290	(1) 6260	—	(1) 5235	40 Hz	800 Hz	Yes (HF)
9922T	3-Way				(1) 6215	(2) 5235		800 Hz, 7 kHz	
9923		(1) 6290			—		30 Hz	80, 800 Hz	
9923T	4-Way				(1) 6215	(3) 5235		80, 800 Hz, 7 kHz	
9942	2-Way	—	(2) 6290		—	(1) 5235	40 Hz	800 Hz	
9942T	3-Way				(1) 6215	(2) 5235		800 Hz, 7 kHz	
9943		(1) 6290			—		30 Hz	80, 800 Hz	
9943T	4-Way				(1) 6215	(3) 5235		80, 800 Hz, 7 kHz	

TABLE OF CONTENTS

TABLES AND ILLUSTRATIONS

INTRODUCTION

JBL Concert Series products are designed to meet critical and demanding touring sound reinforcement and playback applications. Housed in rugged and road-worthy fiberglass-reinforced cabinetry, they will provide years of trouble-free, high-quality portable service.

The engineering design approach marries high-quality JBL/UREI electronic products with concert-proven JBL loudspeaker components for improved sound system performance, while assuring long-term reliability in touring service. Taking advantage of the 5235's flexibility and programmability, we have designed bandpass filters and fixed equalization that result in optimum performance from Concert Series loudspeaker components. Reliable system operation is assured through thoughtful loudspeaker power apportionment, and conservative component operation throughout.

This manual provides information to install and operate Concert Series products for best performance in a wide variety of applications, both portable and fixed. Specific and detailed information on component products may be found in individual component owner's manuals.

INSTALLATION

Electronics

Input Connections

Input connections to 9900 series rack equipment are via balanced XL receptacles. A parallel loop-through connector is provided for each input to enable convenient system expansion. Each input has a polarity reversal switch and a ground lift switch to adapt to a variety of drive conditions.

NOTE: The input polarity and ground lift switches are after the loop-through connector wiring and only affect the input polarity and shield connection internal to the rack.

Balanced Source Connections

Most professional mixers incorporate balanced or symmetrical outputs, which may be connected directly to 9900 racks. When source equipment is some distance from the amplifier racks, and both are properly grounded to the AC ground, the potential exists for a system ground loop. Often, several volts can be developed between different AC grounds served by a common panel. Hum, RFI and other parasitics can result when more than one path to ground is present. Good installation practice dictates that shields be connected at *one end only*, preferably at the load. Where this isn't practical, the ground lift switches may be used to isolate the source ground (shield) from the rack assembly.

Unbalanced Source Connections

The use of unbalanced sources for long cable runs is to be discouraged. Where unbalanced sources must be used, the potential for ground loops can be minimized by treating them as pseudo-balanced sources. This requires isolating the source chassis from the load chassis (except where they are connected through their respective AC grounds), and the use of two conductor shielded cable. The cable shield should be connected at the load end only, and *must not be used as a signal conductor.*

When the 9900 balanced inputs are used in this manner, no ground connection will be made between source and load. This will require the fabrication of

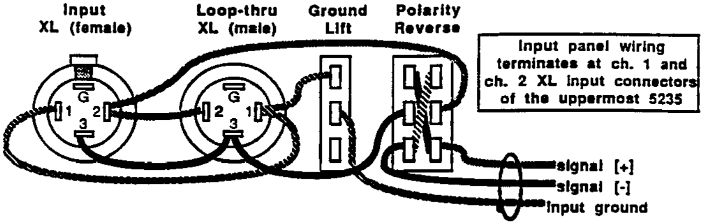


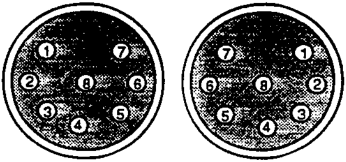
Figure 3—Input Wiring (typical)

special cables, and standard (unbalanced) pre-wired cable adapters must not be used. If these measures are unsuccessful, the output of the source may be isolated and balanced with a transformer, following the manufacturer's instructions. Under no circumstances should an AC "cheater" adapter be used, as this removes the path to ground for fault currents which could occur within the instrument, resulting in a shock hazard.

Output Connections

All amplifier outputs are wired to 8-pin Cannon EP-8 receptacles, for two (stereo) channels, with either two outputs (9922/9922T, 9923/9923T), or four outputs (9942/9942T, 9943/9943T). A single 8-conductor cable assembly connects one loudspeaker to each rack output. Connections to additional loudspeakers are made via the loop-through connectors provided in the loudspeaker systems. The 8-pin output

P-8 Connectors
(Viewed From Solder Side)



Female Connector

Male Connector

Amplifier Output Terminals	Internal Loudspeaker Wire Colors (Where Used)	P-8 Connector Pin Wiring						
		4825/4828	4842/4845	4847	4850/4852 4870/4872	4851/4853 4871/4873	4860/4862	4861/4863
VLF + VLF -	Blue White/Blue	— —	1 2	— —	— —	— —	— —	— —
LF + LF -	Black White/Black	3 4	— —	3 4	3 4	3 4	— —	— —
HF + HF -	Red White/Red	5 6	— —	— —	5 6	5 6	5 6	5 6
VHF + VHF -	Orange White/Orange	— —	— —	— —	— —	7 8	— —	7 8

Figure 4—Output Connector Wiring

receptacles are pre-wired for four-way system operation for convenience of future expansion, with the unused cables tied off within the rack.

Figure 4 shows the EP-8 connectors, as viewed from the solder side. Note that the "+" and "-" designations in the table refer to the amplifier terminals, and not the loudspeaker terminals. For connection to other than JBL Concert Series loudspeaker systems, refer to the loudspeaker manufacturer's terminal designation data.

Connection of 4850 and 4870 systems is limited to one unit per output receptacle. This presents a 4 ohm load to the LF amplifier, which is the minimum impedance that can be safely driven.

NOTE: In 9943 and 9943T racks, output receptacles [1 and 3] and [2 and 4] are parallel-connected within the rack for VLF loudspeakers. These systems are limited to [4] model 4845 or [2] model 4842 loudspeakers, four ohms per output channel of the VLF amplifier. Because parallel connection is also possible at the loudspeaker, system owners are encouraged to adopt hook-up conventions that will prevent the inadvertent connection of four 4845s or two 4842s to one VLF amplifier output.

Absolute Polarity

All Concert Series rack assemblies and loudspeaker systems are wired so that a positive-going signal applied to pin 3 of the input receptacle(s) will result in a corresponding forward diaphragm movement at the loudspeaker(s) when the input polarity switch is in the normal position.

Loudspeakers

General

The consistent successful deployment of Concert Series systems requires that owners and installers familiarize themselves with the performance capabilities of individual loudspeaker systems, and gain a working insight into the performance gains and losses associated with multiple loudspeaker systems.

Ideally, we would be able to place as many loudspeaker systems into the same physical location as needed to deliver the required acoustic power. Since two objects cannot occupy the same space at the same point in time, we have no choice except placing our loudspeaker systems in different locations. While a detailed engineering analysis is beyond the scope and purpose of this manual, the following guidelines have been developed to assist owners and installers to gain maximum performance from Concert Series products:

Minimize Coverage Overlap

When two or more Constant Coverage systems are used, smoothest distribution results when the splay angle between cabinets yields the minumum coverage overlap. For example, if 120 degrees of horizontal distribution is desired, two 60 degree cabinets, with a 60 degree splay angle between the horizontal axes is preferred.

Group Loudspeakers Together

Where wavelengths are long compared to the size of the array (i.e. low frequencies), separate sources behave as though they were one large source, and their outputs sum coherently. Conversely, when wavelengths are short compared to the array size, interference will take place. The interference takes on a comb filter characteristic, alternating between reinforcement and cancellation as frequency increases. The larger the array is, the lower the frequency of interference onset. Place loudspeaker systems as close together as possible consistent with achieving the desired coverage.

Use Fewer Loudspeakers

Using more systems than is necessary for the application will lower the frequency of interference onset by virtue of (the larger) array size, and decrease sound system intelligibility for most of the audience. Use only the quantity of loudspeakers needed to achieve the desired coverage and SPL.

Take Advantage of the Cabinet Shape

Concert Series cabinet "footprints" describe wedge frustums: 30 degrees for the 4845 and 4870 family; 45 degrees for the 4825 and 4850 family. The shape enables moderate horizontal splay angles, while placing loudspeaker components close together. This raises the frequency of interference onset in arrays, thereby reducing overall interference.

Split Clusters

Split loudspeaker clusters are a fact of life in entertainment systems. They broaden the sound field for an audience, and lend a quality of warmth to performers on stage. They are separate sources, however, and they will interfere with one another, lending a slightly "muddy" quality to a performance by decreasing the ratio of direct-to-indirect sound energy for most of the audience. We recommend that the distance between split clusters be held to a minimum, consistent with stage width and system acoustic gain considerations.

Group VLF Systems

Whenever possible, it is advantageous to group VLF loudspeakers into a single VLF array. This will result in increased output over the entire VLF range, as the array will remain small relative to wavelengths within the bandpass.

Hanging Systems

Concert Series loudspeaker systems come equipped with aircraft-style pan fittings to facilitate rigging and hanging. Each fitting carries a rating of 900-2200 kg. (2000-5000 lbs.), depending upon pull angle, and terminates in a round head stud. Load-rated mating hardware is available in a variety of ring and stud fitting configurations from:

Stanal Sound, Ltd.
7351 Fulton Avenue
North Hollywood, CA 91605, USA
1-818+764-5200

The design of hanging systems for loudspeaker clusters is beyond the scope of this manual. Remember, that anything that is mounted overhead carries certain (and significant) liabilities to owners, installers and operators. **JBL assumes no responsibility for damages, either direct or consequential, that may result from accidents associated with the design, installation and operation of hanging loudspeaker systems.** Where hanging systems are to be fabricated, the following guidelines should be used:

1] Obtain the services of a licensed structural engineer for the design of all hanging systems, grids, and the location of appropriate hard points in the facility in which you plan to hang loudspeakers.

2] Use professional riggers for all hanging assignments. This work is dangerous and demands the services of an experienced professional.

3] Always insist upon backups to the primary rigging hardware in the event of mechanical or structural failures.

4] Always use premium-grade hardware and equipment, appropriately rated for the loads being carried. Your structural engineer will be able to advise you as to details.

5] Make certain that you have liability insurance that covers this kind of work, and that premiums are kept up to date.

For more information on hanging loudspeaker systems, contact your JBL Concert Series dealer or Stanal Sound, listed above.

Typical System Configurations

Loudspeaker system array techniques are shown in the following examples, along with performance characteristics for each example. We have selected the 4870 loudspeaker to illustrate the performance characteristics, however, the principles governing these characteristics apply to all of the Concert Series loudspeaker products. While the examples in no way exhaust the enormous range of available possibilities, they are indicative of a wide range of typical applications.

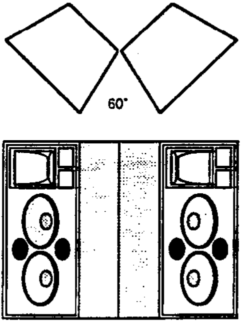


Figure 5—Two 4870 Loudspeakers Wide Coverage

Frequency Range:	**35 Hz to 20 kHz**
HF Distribution	
Horizontal:	**170 Degrees**
Vertical:	**40 Degrees**
Continuous Pgm. SPL:	**132 dB @ 1m.**
Total Amplifier Power:	**1350 watts**

In this example, the 4870 systems are splayed 90 degrees between each loudspeaker's principal axis. This requires a 60 degree angle between adjacent cabinet sides. Performance characteristics will be essentially those of individual 4870 systems, with minor high frequency response aberrations in the forward quadrant.

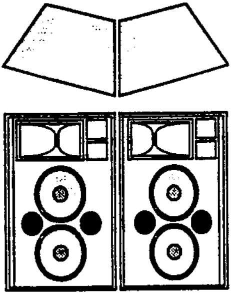
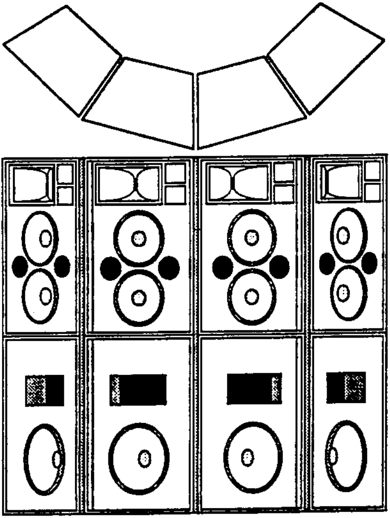


Figure 6—Two 4870 Medium Coverage

Frequency Range:	35 Hz to 20 kHz
HF Distribution	
Horizontal:	120 Degrees
Vertical:	40 Degrees
Continuous Pgm. SPL	135 dB @ 1m.
Total Amplifier Power:	1350 watts



In figure 6 the two loudspeaker systems are placed side-by-side, such that there is a 30 degree angle between each 4870's principal axis. This results in nominal 120 degree horizontal coverage, but with a 3 dB to 4 dB lobe in the frontal quadrant—useful in many applications.

The system configuration shown in figure 7 employs all of the 4943 components in a single array. Because the array is quite large, there will be some middle and upper frequency "fingering" of horizontal coverage. However, this will be less than would result if the enclosures were to be separated. Vertical coverage remains that of single units. Low frequency coupling will be excellent.

Figure 8 illustrates one technique for increasing vertical coverage. The vertical angle between cabinets can vary between 20 and 40 degrees to achieve the desired coverage. Some on-axis lobing is to be expected, along with "fingering" of coverage along the vertical axis. Horizontal coverage will remain that of single units.

Figure 7—Four 4870 Wide Coverage With VLF

Frequency Range:	20 Hz to 20 kHz
HF Distribution	
Horizontal:	170 Degrees
Vertical:	40 Degrees
Continuous Program SPL:	140 dB @ 1m.
Total Amplifier Power:	5100 watts

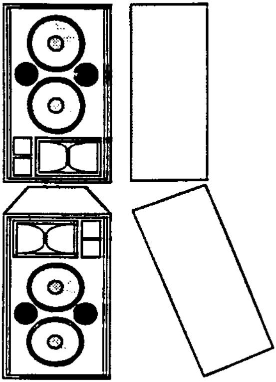


Figure 8—Two Loudspeaker Wide Vertical Coverage Array

Frequency Range	**35 Hz to 20 kHz**
HF Distribution	
Horizontal:	**90 Degrees**
Vertical:	**60-80 Degrees**
Continuous Pgm. SPL:	**135 dB @ 1m.**
Total Amplifier Power:	**1350 watts**

SETUP AND OPERATION

AC Power Connections

Systems prepared for North America operate on 120 V (nominal) AC mains, and are equipped with three-conductor supply cords and plugs.

NOTE: All 9900 series rack assemblies are wired for balanced input connections. Removing the ground pins will serve little purpose in preventing ground loops, and could present a shock hazard under certain conditions of operation. The grounding pins and added mechanical integrity to receptacle connections, and should be retained for that purpose, as well as for safety reasons.

The supply of AC mains power distribution to 9900 series racks is the responsibility of the owner/installer. Figure 9 lists AC requirements for domestic and international (220/240 V) versions of 9900 series rack systems. Installers should check local regulations for circuit and conductor current limitations, and design the AC service accordingly.

	Power Consumption (watts)			Current (amps)	
System	Idle	Rated Output	-10 dB Power	120 V	220 V/ 240 V
9922	175 W	2600 W	875 W	22	11
9922T	185 W	2700 W	910 W	23	12
9923	300 W	4000 W	1350 W	33	17
9923T	310 W	4100 W	1385 W	34	18
9942	300 W	4600 W	1500 W	38	19
9942T	310 W	4700 W	1535 W	39	20
9943	425 W	6600 W	2000 W	55	23
9943T	435 W	6700 W	2035 W	56	28

Figure 9—Table of Power and Service Requirements

Three tabulations of power consumption have been listed to aid in system planning. Power consumption at idle is provided for users that don't plan on switching the system off. (Many contend that leaving the system powered up at all times greatly extends the service life of electronic components.) Consumption at rated output is calculated on the basis of rated load impedance, reflecting a worst-case (although somewhat unrealistic) usage situation. Power at -10 dB reflects a realistic demand for actual operation, and is useful for planning electric power and building heat loads. Current has been calculated for 120 V and 220/240 V operation, and indicates wiring and service requirements.

AC Connections for Portable Applications

Connecting to an unknown power source is a potential hazard to equipment and operator, and can result in total system failure (and loss of show). To prevent such a disaster, system operators are urged to obtain an electrician's circuit tester, and to verify that each and every AC receptacle to be used is of the proper voltage and correctly wired with respect to neutrals and safety grounds.

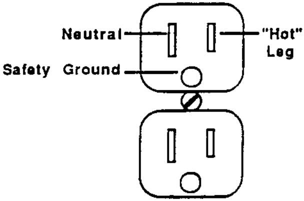


Figure 10—North American AC Receptacle Wiring

Figure 10 shows a standard duplex receptacle common to North America. The large pin on the left is the "neutral" connection, which is wired to the neutral bus at the power panel, which is grounded by means of an earth ground located nearby. The power transformer secondary center tap is also carried to earth *at the power pole*. The "safety ground" is normally strapped to the receptacle frame and physically connected to the neutral (hence ground) via mechanical conduit connections. In installations that do not use metal conduit, a separate ground wire is returned to the neutral bus in each "leg" that is fed from the power panel. The "hot" leg is wired to the power transformer secondary through circuit breakers. In the U.S.A., the white wire is "neutral", the green wire is "safety ground", and black is "hot" (although any other color except white and green may be encountered as "hot").

In earlier receptacles the vertical pins are similar in size, however, the neutral should always be on the left. Checks for AC power should include:

1] Verification that the neutral pin is the left-hand pin (receptacle oriented as above).

2] Verification that all neutrals in the system are at the same voltage potential.

3] Confirmation that the voltage between "hot" and "neutral" is 120 V (nominal).

4] Confirmation that no voltage potential exists between "neutral" and "safety ground".

5] Verification that the wiring and service breakers are of a current rating sufficient to power the system (see load table).

Powering the System Up

After verification of AC supply integrity, and before energizing AC power to rack-mounted equipment:

1] Verify that all source equipment is powered up. Many mixing consoles and signal processing devices have severe turn-on and turn-off transients, which could prove hazardous to loudspeaker components if switched on or off with the power amplifiers energized. This also holds true for microphone and pickup power supplies, should a fader channel be open.

2] Rotate all power amplifier level controls fully closed. This is further loudspeaker protection should a high-level source signal be present at the system inputs. If the mixing console is manned, be sure that the operator is aware that amplifiers are being powered up. (The operator could be adjusting compressor thresholds with 0 VU of 1 kHz at the console outputs.)

3] With the power amplifier level controls fully closed, switch the AC power on. Amplifiers should be switched on individually in large systems, rather than at the circuit breakers.

4] Slowly raise the amplifier level controls to their pre-set positions. Should a signal be present at the input, this procedure will enable its detection before damage occurs.

Powering the system down is simply a matter of switching the power amplifiers off first.

Level Setting Procedure

Because the 5235 crossovers are fitted with dedicated Concert Series processing cards, level adjustments have been made remarkably easy. The following alignment procedures call for a spectrum analyzer. Alternately, the levels can be balanced with familiar program material following the same steps.

NOTE: The recommended procedure operates all electronics with the level controls nominally full open. This improves signal-to-noise, greatly reduces the possibility of inadvertent mis-alignment, and enables rapid confirmation of level settings. In the remote possibility of a component failure, a similar device may be quickly substituted, and the system returned to its correctly balanced operation, even in the dark.

The 5235 crossovers used in the Concert Series have been equipped with HF power response correction, enabling substantially flat power response from Concert Series loudspeaker systems, but it is seldom possible to measure this on site. Atmospheric absorption of short wavelength energy at typical measurement distances can attenuate the 10 kHz region 10-12 dB below levels at 1 kHz (a perfectly natural phenomenon that generally should not be compensated for), and the directivity-frequency properties of microphones can lead to significant high frequency measurement errors. If in doubt, listen to the system using familiar program material.

NOTE: Often engineers adjust the LF and HF level controls in combination with adjustment of house EQ devices. This practice leads to inconsistent and poor system performance, and is to be discouraged. All level settings should be performed with house and program equalizers bypassed.

For permanently installed systems, it is advisable to install security covers to safeguard the amplifier level control settings. The model 6200SC security cover kit is available from JBL dealers for this purpose. Refer to the 6260 or 6290 Owner's Manual for installation instructions.

After preliminary checks for signal continuity, freedom from hum or parasitics, with the system powered up and all power amplifier level controls fully closed (counter-clockwise), rotate all 5235 level controls fully clockwise (open). Slowly open the power amplifier level controls to their full clockwise rotation.

Two-Way Systems (4922 and 4942)
Using pink noise as a program source, adjust the system level at the mixer for a comfortable output level from the Channel 1 loudspeakers. Observe the microphone output on the analyzer. The octave bands bounded by 200 Hz - 400 Hz and 1 kHz - 2 kHz should be at the same relative levels. Should a disparity be observed, the higher level can be easily and accurately attenuated at the respective power amplifier(s). Repeat this procedure for Channel 2.

Figures 11-14 show component mounting locations and output assignments. The number associated with each output assignment refers to the 8-pin output receptacle on the input/output panel, which is mounted to the rear rack rails of each respective cabinet.

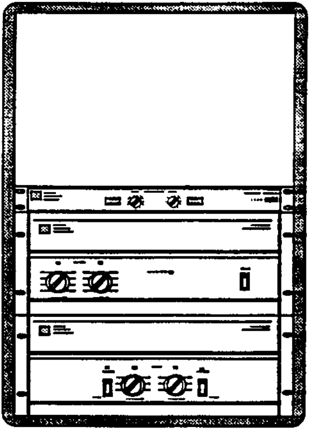


Figure 11—9922 Equipment Rack

9922 Output Assignments

6260
Channel 1—HF Output 1
Channel 2—HF Output 2.
6290
Channel 1—LF Output 1
Channel 2—LF Output 2.

The 9922 equipment rack is shown in Figure 11, along with output assignments and component designations. The 5235 is operated as a two-channel crossover system, with Channel 1 driving power amplifiers that service output connector #1, and Channel 2 driving power amplifiers connected to output connector #2.

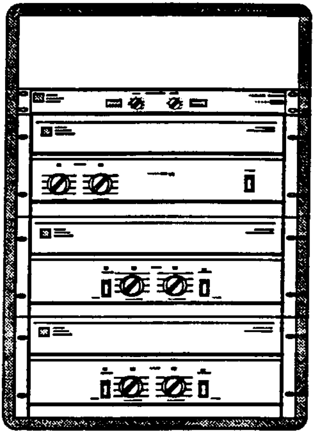


Figure 12—9942 Equipment Rack

9942 Output Assignments

6260 (Top)
Channel 1—HF Outputs 1 & 3
Channel 2—HF Outputs 2 & 4.
6290 (Middle)
Channel 1—LF Output 1
Channel 2—LF Output 2.
6290 (Bottom)
Channel 1—LF Output 3
Channel 2—LF Output 4.

Figure 12 shows the 9942 equipment rack, along with component designations and output assignments. Note that there is one LF output assignment per 6290 output channel, and two HF output assignments per 6260 output channel. The 5235 is operated as a dual-channel crossover, with Channel 1 driving power amplifiers serving odd-numbered outputs, and Channel 2 driving power amplifiers that serve even-numbered outputs.

Adding Subwoofers

Adding subwoofers to the basic two-way systems requires the 9923 or 9943 amplification and signal processing electronic racks. The uppermost 5235 in either rack handles the 800 Hz crossover and signal processing, while the lower 5235 performs the processing below 80 Hz. The LF level controls are on the bottom 5235 and the HF controls are on the top 5235. Channel one controls odd numbered outputs and channel two controls even numbered outputs. There are no VLF controls on the 5235s.

The recommended set-up procedure for three-way systems is similar to that previously described for the two-way systems, except for the addition of the VLF loudspeakers. If an analyzer is to be used in set-up, a good-quality calibrated omnidirectional condenser microphone will be required, as most dynamic microphones roll off in response above the VLF range.

Rotate all 5235 and power amplifier controls to their full open (clockwise rotation) positions. Using pink noise as a program source, adjust the level at the console for a comfortable output level from the Channel 1 loudspeakers.

WARNING: Human tolerance for high levels in the low bass region can easily result in over-driving of the VLF loudspeakers, especially on band-limited pink noise. Raise the drive level slowly, and be alert for "popping" sounds, which are indicative of undue stress on the loudspeakers or clipping of the signal. Should this occur, a reduction in level could substantially extend useful loudspeaker life.

With a reference level established on the analyzer, observe the relative levels in the 40 Hz - 80 Hz, 200 Hz - 400 Hz and 1 kHz - 2 kHz octave bands. Beginning with the octave band of highest amplitiude, adjust the respective power amplifier level control(s) to smooth the response. Use the minimum attenuation possible to equalize the amplitudes of these octaves. Repeat this procedure for channel 2 loudspeakers.

After these adjustments, it is prudent to double-check split systems with all loudspeakers operating, making any necessary level adjustments at the respective power amplifiers.

NOTE: Adjusting levels at the 5235s is not recommended in Concert Series electronics.Optimum signal-to-noise and dynamic headroom is realized in the Concert Series with all 5235 controls fully open. The power amplifier level controls are detented and calibrated to enable precise and repeatable level adjustment.

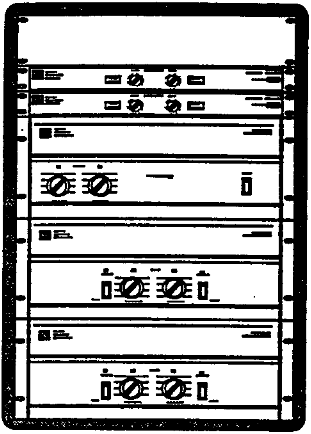


Figure 13—9923 Equipment Rack

9923 Output Assignments

6260 (Top)
Channel 1—HF Output 1
Channel 2—HF Output 2.
6290 (Middle)
Channel 1—LF Output 1
Channel 2—LF Output 2.
6290 (Bottom)
Channel 1—VLF Output 1
Channel 2—VLF Output 2.

In the 9923 system, two 5235 crossover systems are provided for three-way operation. The upper 5235 provides 800 Hz signal processing. Its high pass outputs drive the inputs of the 6260 HF amplifier and the low pass outputs drive the inputs of the bottom 5235. The lower 5235 contains 80 Hz signal processing; its high pass outputs drive the 6290 LF amplifier and the low pass outputs drive the VLF 6290. Channel one controls affect channel one outputs, likewise for channel two.

The 9943 is a two-channel three-way rack system, with output assignments as shown in Figure 14. System inputs feed the top 5235, which is equipped with 800 Hz crossover cards. The high pass outputs drive the HF amplifiers, and the low pass outputs drive the inputs of the bottom 5235. The lower 5235 high pass outputs are connected to the LF amplifiers, and the low pass outputs drive the VLF amplifier inputs. The top 5235 level controls affect odd and even numbered HF outputs, while the bottom 5235 level controls affect the odd and even LF outputs.

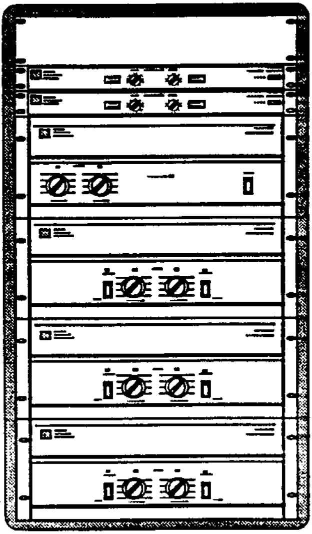


Figure 14—9943 Equipment Rack

9943 Output Assignments

6260 (Top)
Channel 1—HF Outputs 1 & 3
Channel 2—HF Outputs 2 & 4.

6290 (Second)
Channel 1—LF Output 1
Channel 2—LF Output 2.

6290 (Third)
Channel1—LF Output 3
Channel 2—LF Output 4.

6290 (Bottom)
Channel 1—VLF Outputs 1 & 3
Channel 2—VLF Outputs 2 & 4.

Systems with VHF Transducers

Three-way loudspeaker systems, models 4851, 4853, 4871 and 4873 require 9922T or 9942T electronics. When configured with subwoofer systems, the electronics systems become models 9923T or 9943T.

Adding VHF loudspeakers to existing 9922, 9942, 9923 and 9943 amplification systems requires the addition of [1] 5235 with [2] 7 kHz crossover cards (JBL part no. 52-5127) and [1] 6215 amplifier to the electronics rack. Signal flow for the 9922T/9942T is shown in figure 16. Figure 18 illustrates the signal flow for 9923T and 9943T systems.

The two-way loudspeakers, models 4850, 4852, 4870 and 4872 are equipped for the optional provision of [2] JBL Model 2404H VHF loudspeakers for increased output above 10 kHz. Installing the VHF transducers requires the removal of the grill assembly which is held in place by [4] #10-32 screws and protective washers. Remove the two blanking plates located to the right of the HF horn and release the cable ties holding the two VHF cable pairs. Bring one cable pair through each mounting hole, and connect the orange wire to the black terminal, and the white-orange wire to the red terminal of each 2404H. Mount the 2404Hs using the screws provided in the horn mounting kit.

The two 2404Hs are series-wired at the input plate for 16 ohm impedance. The VHF loudspeaker input is across terminals 7 and 8 of the loudspeaker system input connector, with *terminal 7* for connection to the amplifier's "positive" output terminal. A series capacitor with a polypropylene shunt provides DC blocking and single-pole bandpass filtering for signals one octave below the recommended crossover frequency of 7 kHz.

WARNING: Do not connect the VHF drivers to an amplifier that does not derive its input from a high pass filter having at least 12 dB/octave roll-off below 7 kHz. To do so will subject the 2404H diaphragms to excessive mechanical displacement in concert service, and probable failure.

The input panel connects to the newly added 5235, which is equipped with two 7 kHz crossover cards. The high pass outputs drive the 6215 VHF amplifier. The low pass outputs drive the second (numbered from the top of the rack) 5235, fitted with two 800 Hz crossover cards and HF response equalization. The middle 5235 high pass outputs drive the 6260 HF amplifier, while the low pass outputs feed the bottom 5235 for LF and VLF processing.

Loudspeaker Dollies

Optional loudspeaker dollies, Models 4850DL and 4870DL, are available from JBL Concert Series Dealers. The 4850DL fits Models 4850-53, while the 4870DL fits the 4842, 4845, 4847, 4860-63, 4866 and 4870-73 loudspeaker systems. To use the dollies:

1] Install the wheels to the dolly frame, using the hardware provided.

2] With the loudspeaker system upright, tilt the dolly on end in front of the loudspeaker and lift the dolly to engage the Velcro fasteners at each of the four corners of the grill assembly.

3] With the dolly firmly attached to the loudspeaker assembly by the Velcro, tilt the loudspeaker forward until the cabinet is horizontal and resting on the dolly. Pulling on the dolly will only remove it from the loudspeaker.

4] To remove the dolly from a loudspeaker, tilt the loudspeaker upright, and extract the dolly by pulling it away from the cabinet, starting at the top.

5] The dollies were designed to allow stacking of loudspeakers for transportation and storage while mounted. The underside of the dolly frames are shaped to index with the rear of the underneath cabinets, and padded with rubber to prevent sliding.

Loudspeaker Cable Assemblies

Two standard loudspeaker extension cable assemblies are available for Concert Series use. Model 3805 is a 5 foot extension, and the Model 3850 is 50 feet in length. Cables are 8-conductor 12.5 AWG wire, terminated with 8-pin Cannon™ EP-8 connectors, one each male and female.

Loudspeaker cables should be kept to the minimum length required in the interest of efficient power transfer. 12.5 AWG cable has a resistance of less than 4 ohms per 1000 feet, which will result in less than 1/2 dB loss over a 50 foot cable run with a 4 ohm loudspeaker load.

Electronics Cases

Two accessory cases are available to protect Concert Series electronic racks in portable service. Both cases are constructed from fiberglass reinforced plywood and mounted on heavy-duty casters for ease of handling. Cases part near the bottom of the rack, allowing rack assemblies to remain in the lower pod during operation. The 9916RC fits 9922, 9922T, 9923, 9923T, 9942 and 9942T racks. The 9920RC fits the 9943 and 9943T racks. Installation and operation are straightforward.

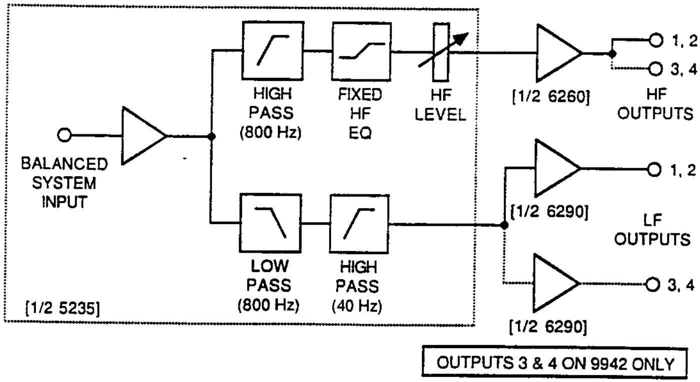


Figure 15—9922/9942 Signal Flow

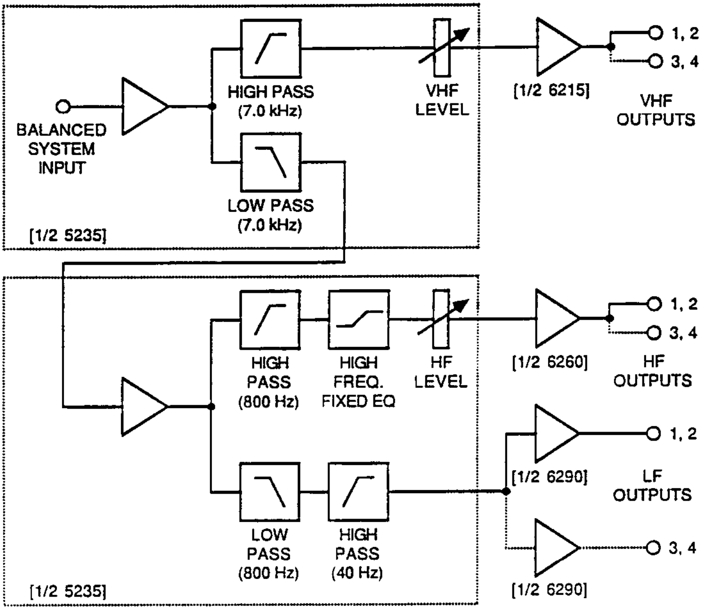


Figure 16—9922T/9942T Signal Flow

Maintenance

Concert Series electronic products are assembled from all solid-state components, ruggedly constructed with only the highest quality parts. As such, they will provide years of trouble free service with normal care. No special preventive maintenance is required, other than regular cleaning.

Loudspeaker systems should be fully tested before each performance. Touring systems in regular service should be routinely dismantled and examined for shipping and handling damage, including removal and careful inspection of compression driver diaphragms. These procedures should be done by qualified personnel, and in accordance with published methods.

Connections are the greatest source of potential difficulties in portable sound systems. Cables and connections should be carefully inspected and tested prior to sound checks for each new show installation. All internal rack wiring is labeled with the appropriate channel number, and color-coded in accordance with the following convention:

Blue: VLF
Black: LF
Red: HF
Orange: VHF

Troubleshooting

Because most Concert Series products are used for amplification of live performance, defects need to be rapidly identified and corrected. While there is no best technique for troubleshooting large systems, we encourage using systematic procedures to isolate defects.

Operators need to understand the functions of each component and their relationships with other components in the system. Carefully study the appropriate signal flow diagram in this manual, and commit it to memory. Keep a copy of this manual with the equipment at all times as a handy reference.

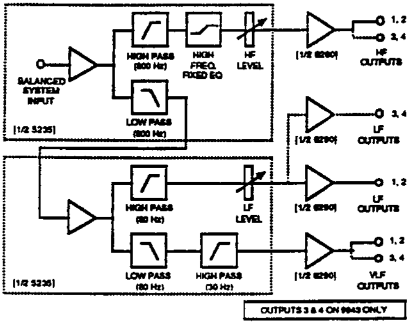


Figure 17—9923/9943 Signal Flow

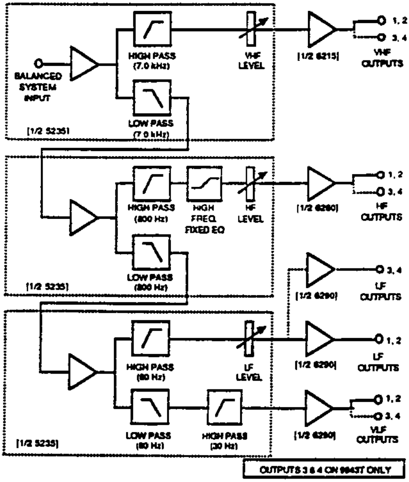


Figure 18—9923T/9943T Signal Flow

Figure 19—Concert Series Accessories