NOTES ON 70-VOLT AND DISTRIBUTED SYSTEM PRESENTATION
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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 of speaker A's 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 "dB's 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
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 Autoformer/ Transformer #	Input Impedance	70 volt Output	Impedance Matching *	Impedance Ratio
9375	4 ohms	100 W	8-32 ohms	1:8
6217	4 ohms	45 W	111 ohms	1:28
6237	4 ohms	150 W	36 ohms	1:9
6267	4 ohms	300 W	16 ohms	1:4
6297	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	x W	x D	Weight	Shipping Weight
9375	100 W	3.5	4.13	3.0	6	7
6237AFMR	150 W					
6237XFMR	150 W	4.0	3.25	3.5	7	8
6267AFMR	300 W					
6267XFMR	300 W	4.5	3.5	3.75	9	10
6297AFMR	600 W					
6297XFMR	600 W	4.5	3.75	3.75	10	11

NOTE: Suffix AFMR denotes autoformer, XFMR denotes dual winding true transformer.