OPERATOR'S MANUAL

Model GL60
Reverberation Time Analyzer

The Model GL60 measures the reverberation time; the measure of how long sound takes to decay by 60 decibels (dB) in a room. The GL60 meter does this by measuring how long a sound level takes to drop by 20dB and then multiplies that time by three to give a standard readout.

Features: Since frequencies decay at different rates, the GL60 meter measures reverberation time at six different frequencies (125, 250, 500, 1000, 2000, 4000 Hertz). Frequencies over 4000Hz are not provided, since they are mostly absorbed by the humidity in the air. Three different sensitivities are provided to allow for background noise and room size. Measurements are displayed in seconds from 1 to 10 seconds in 100ths of a second.

Using The GL60: To obtain valid RT60 measurements it is important to suppress, whenever possible, noise caused by heating or air-conditioning systems, fans, or other foreign noise that could interfere with the measurement. Measurements are best taken when traffic noise or activity is at a minimum. Measurements of RT60 require a sound level of **at least 2ldB ABOVE the AMBIENT SOUND.** It is therefore necessary for the triggering sound source to be a minimum of 2ldB above the ambient sound at each of the measured frequencies.

1. SET FREQUENCY to be measured.
2. SET SENSITIVITY (start with **-30)**
3. TRIGGER the NOISE SOURCE (We suggest a GOLD LINE **PN3A** with the **STA** SETTING.)

The noise source must be a short duration pulse like the sound produced by a breaking balloon. The **STA PULSE** produced by the PN3A is ideal since it will repeat AUTOMATICALLY allowing the user to run multiple readings to verify that the RT60 reading is repeatable and therefore valid.

4. If the meter does not trigger and RESET to an RT60 measurement, INCREASE the LEVEL of the NOISE SOURCE and REPEAT the measurement. Set the SENSITIVITY CONTROL to **-15** and repeat the test. The 0 SETTING is only useful in a very silent room with a low level noise source which is at least 2ldB ABOVE the AMBIENT SOUND of the room.

What Is Reverb Time: Reverb time is defined as the time that a sound, once stopped, takes to decay by 60dB. A sound played in a room will bounce off\ the walls. If the walls do not absorb any sound, the volume in the room will continue to increase as long as sound is being added. Even if the sound were shut off, the volume would not drop because there would be no place for the sound to go. In any real room, the walls absorb sound. The more they absorb, the faster the volume will drop off after the sound in stopped. Certain materials, such as rugs, absorb a lot of sound. Materials such as plaster and glass absorb almost none. The absorption also varies with the frequency of sound. Large rooms have a much greater volume inside for the amount of wall surface, so they tend to have more reverb than small rooms. Reverb time is our method of comparing the amount of bouncing sound (reverberation) in different rooms. (Echo is considered to be the result of a single bounce.)

Absorption and Reverb Time: The reverb time in a room is equal to .049 times the volume of the room divided by the total absorption of the room. The unit of absorption is called the sabin. (Tables of standard sabin values are available in many texts on sound system engineering.) The higher the rating, the greater the absorption. Absorption also varies with the frequency. The GL60 meter allows you to measure the contribution of a room to your sound. It can enable you to get the most from the room or point you in the right direction to improve it.

Speaker Placement: The GL60 meter can be used to assist in selecting speaker locations. If the trigger sound (a hand clap or pulse through the speakers) is placed where the speaker stack will be and the GL60 meter is used in the audience position, meaningful measurements may be taken. If the meter shows a very non-uniform reverberant field, a different location for the speakers may be better. If the meter reads similar numbers, all under 1.00 seconds, then the room is flat and good speech intelligibility should be obtained. In midsize rooms, a reverb time of 1.5 seconds should be a good reading. The low frequency readings may rise above the rest for best sound quality, particularly in churches or other places where organ music is played. The GL60 is useful for estimating how far a loudspeaker will "throw" in a reverberant environment. Research has shown us that a good orator talking to a receptive audience in a room with 1.50 seconds reverb time will yield good results. For a less well trained orator and a typical audience, 1.00 seconds may be better.

We can use the GL60 to determine at what distance a speaker will reinforce sound to provide the same 1.50 (1.00) second equivalent reverb time. To do this, make a sound from the speaker location and move the GL60 away until it reads 1.5 (1.0) seconds. The distance at which the GL60 reads 1.5 (1.00) seconds is how far a loudspeaker with a Q (directivity factor) of 1 will throw.

If we are going to use a multiple speaker system, we can space our time delayed distributed speakers at this distance. (The coverage angle, C_L, also has to be taken in consideration) If a point source array is preferred, we can calculate the Q required. We divide the total speaker throw required by the distance at which we obtained our acceptable reading, and then square this number (multiply it by itself). That yields the Q required. As an example, in a room 100' long, make a sound from the front center. As we move the GL60 back, we find that the reading is 1.50 seconds at a distance of 25'. We can then calculate $(100/25)^2 = 16$. Thus a loudspeaker with a minimum Q of 16 should project to the back of the room. This method gives you a quick estimate of speaker performance, but you must be sure to give full consideration to the change in reverb time whether the room is empty or full and to the nature of the reverb time. (Long reverb times will change the throw of the speaker).

Microphone Placement: The GL60 can help in determining microphone placement. If you want a dry sound (no reverb), place the microphone where the GL60 shows the lowest reverb time. It's typical to use the 500Hz octave for this application. The best use comes in finding a balance between too much natural reverb and not enough in live situations. Move the GL60 back from the sound source's location until it reads from 1.0 to 1.6 seconds. That's where to try the microphone. The 1.0 range is better for omnidirectional microphones or stereo pairs. The 1.6 range is better for cardioids, hyper cardioide or shotguns.

Predicting Reverb Time: The most common formula for predicting reverb time is the Sabine equation. It is: T_{60} =.049 x Volume / (Surface area x Average absorption). The volume is the total volume of the room in cubic feet. Surface area is the total for all walls, floor and ceiling in square feet. The average absorption is found in the manufacturer's literature for the wall, floor and ceiling coverings or can be looked up in tables found in acoustics texts. The Sabine equation loses considerable accuracy when used in small rooms with reverb times of less than 2.0 seconds or where the construction materials do not have the same absorption values as assumed. The best way to get the reverb time is to measure it with the GL60 several times and in several locations, then average the results. Some large rooms are actually combinations of several rooms. In this case, it is possible to measure the reverb time for each sub-room and for the entire room from one end to the other. The best value to use will depend on what you are using the reverb time measurement for.

Reverb In A Studio: Almost all rooms have some amount of reverberation. It is both the amount (reverb time) and how it changes with frequency that effects our perception of how things sound in that room. The GL60 lets you measure this. The simplest method is to place the GL60 where your ears would be when listening to the playback speaker and to make a sound from the speaker location. Adjust the sensitivity control for the most consistent readings. Do this for all six frequencies.

If the reverb time (T_{60}) is exactly the same at all frequencies, the room is extraordinarily flat. It is typical to see that the bass frequencies (125, 250) are more reverberant than high frequencies. They typically can be 30% higher (e.g. T_{60} @ 2000Hz = 1.00 seconds, T_{60} @ 250Hz. = 1.30 seconds). These types of readings are fine.

A problem is encountered when one frequency has a longer reverb time than the rest.

125	250	500	1k	2k	4k
1.30	1.28	2.40	1.15	1.17	1.01

The example given here shows that something is not right. The 500Hz octave is too high. A mid-bass trap may be required to solve this problem (or try rearranging the furniture). Adding more sound absorbing material could change the numbers to something like this:

125	250	500	1k	2k	4k
.80	.75	1.14	.55	.43	.38

This would deaden the room but would not solve the problem. If we tried to solve the problem with an octave equalizer, we would take out far too much of the music. A more detailed analysis of the problem may help us. This can be done with a calibrated oscillator and the GL60. Set the oscillator to the frequencies as shown in the test table on page six. Patch the oscillator output through a noise gate or tone burst generator. Set the output to 1/8 second duration and at least a 10 second cycle. If you use a noise gate, inject some noise with your finger into the key input causing it to momentarily gate the oscillator on. In either case you will get a short duration pulse of the desired frequency through the system. Increase the level of the signal until the pulse fires the GL60. Record the reverb time as shown by the GL60. Do this five times for each frequency in the table. Now repeat the procedure for the other monitor speakers. You should now have a very good picture of how sound decays in your studio or room. Typically, some of the frequencies will have widely different readings. There will likely also be some reverb times that are longer than the rest; usually these are clustered together. Both of these types of flaws are what cause a smearing of the sound. What is happening is that notes at these frequencies hang around longer and mask the notes that follow. The cure is not very difficult. This is where a good notch filter can be used. If we set a sharp notch (1/12 octave to 1/24 octave) to cut (15-30dB) out the center frequency of our problem area, the sound quality should improve noticeably.

Testing A Sound System: You can quickly check a sound system's performance with the GL60. Make a sound in front of a microphone with the sound system both on and off for all six frequencies. If the reverb time measured from the audience area goes down when the sound system is on, the sound system is improving speech intelligibility. If the reverb time goes up when the sound system is on, it may mean that too many microphones are just picking up reverb or that there are too many overlapping speakers.

	Good		Bad		Great	
Hz	On	Off	On	Off	On	Off
125	1.5	1.3	0.8	1.8	1.0	2.3
250	1.2	1.3	1.7	1.4	1.0	2.1
500	1.0	1.1	1.9	1.6	1.0	1.9
1k	0.8	1.1	2.1	1.8	1.0	2.0
2k	0.6	1.0	1.7	1.7	1.0	1.7
4k	0.6	1.0	1.5	1.2	1.0	1.5

As you can see, the good system provides an increase in the listener's apparent closeness except at low frequencies. The bad system puts the listener in a more reverberant environment--and one that has weak bass at that! The great system allows the audience to hear as if they were in a studio.

Batteries: The most economical battery life is available from alkaline batteries. They should yield 15 hours of use. Carbon-zinc batteries are not recommended, as their electrical characteristics when weak will cause the meter to be less accurate. Usually, neither mercury or lithium batteries are worth the additional cost. Remove the two screws from the bottom of the case. Carefully separate the two halves of the case to expose the battery clips. Install two 9 Volt alkaline batteries. Close the case.

TABLE OF TEST FREQUENCIES

GL60 Freq.	125	250	500	1k	2k	4k
Osc. Freq.	88	176	352	703	1408	2816
	90	181	362	725	1449	2899
	93	186	373	746	1492	2983
	96	192	383	768	1535	3071
	99	198	395	790	1580	3161
	102	203	407	813	1627	3253
	105	209	419	837	1674	3349
	108	215	431	861	1723	3447
	111	222	443	887	1774	3546
	114	228	456	913	1827	3652
	117	235	470	940	1879	3759
	121	242	484	967	1935	3869
	124	249	498	996	1991	3982
	128	256	512	1024	2050	4099
	132	264	527	1055	2109	4219
	136	271	543	1086	2171	4343
	140	279	559	1118	2235	4470
	144	288	575	1150	2301	4601
	146	296	592	1184	2368	4736
	152	305	609	1219	2437	4875
	157	314	627	1254	2509	5018
	161	323	646	1291	2582	5165
	166	332	664	1329	2658	5316
	171	342	684	1368	2736	5472

Notes:

SPECIFICATIONS

MICROPHONE: Built-in omnidirectional electret condenser.

MEASUREMENT FREQUENCIES (Hz): 125, 250, 500, 1k, 2k, 4k.

MEASUREMENT RANGE: 0.01s - 9.99s in 0.01s increments.

DISPLAY: 3 Digit LCD

SELECTABLE INPUT ATTENTUATOR: -30dB, -15dB, 0dB.

POWER REQUIREMENTS: 2 - 9V Batteries. Alkaline recommended.

SIZE (W x H x D); WEIGHT: 5" x 5" x 2¼"; 1 lb.

CASE & REAR PANEL MATERIAL: High impact ABS.

FRONT PANEL MATERIAL: Painted Aluminum.

WARRANTY and Factory Service

GOLD LINE products are proudly made in the USA and are covered by a one year limited warranty. For details of this warranty, consult the enclosed warranty registration card or your local dealer.

GOLD LINE Customer Service will help you get the most from your new analyzer. For answers to questions regarding use of the unit, or for information not covered in this manual, please write us. If you are experiencing difficulties with your analyzer, please consult your dealer regarding factory service. If factory service is needed, you may call or fax us between 9:00am and 4:30pm US Eastern Time for instructions and a return authorization.

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