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dbx MODEL 20/20 COMPUTERIZED EQ/ANALYZER

Manufacturer's Specifications

Equalizer Section

Filter Center Frequencies: 31.5, 63, 125, 250, 500, 1k, 2k, 4k, 8k, and 16k Hz.
EQ Range, Each Filter: -15 to +14 dB.
Resolution: One-dB steps, ±0.25 dB.
Maximum Input or Output Level: +15 dBV (5.6 V).
S/N Ratio: 80 dBA re 1 V.
THD: 0.01%, 20 Hz to 20 kHz.
Computer EQ: Typically within ±1 dB, 18 iterations within 15 S.
EQ Memory: Stores 10 curves.

RTA Section

Filter Center Frequencies: As above.
Relative Accuracy: ±1 dB.
SPL Calibration: Within 3 dB.
Display: From -15 to +14 dB in each band with 1-dB steps, with horizontal bar LEDs.
Band Detector: Average responding.
SPL Range: From 45 to 124 dB, ±3 dB.
SPL Detector: Rms responding.
Microphone Type: Electret condenser, omnidirectional.

General Specifications

Dimensions: 19 in. (483 mm) W x 5¼ in. (133 mm) H x 12¼ in. (311 mm) D.
Weight: 21 lb. (9.5 kg).
Price: $1,500.00.

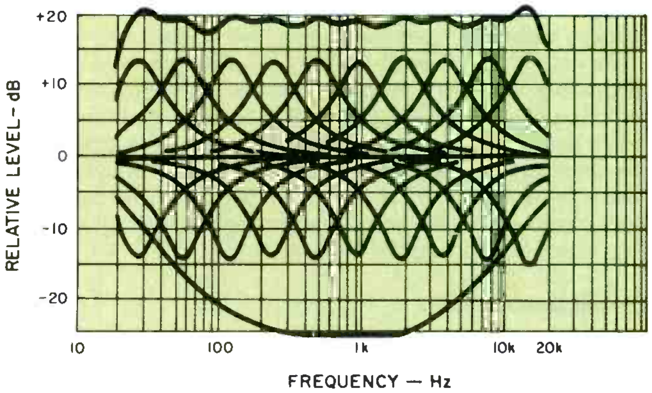
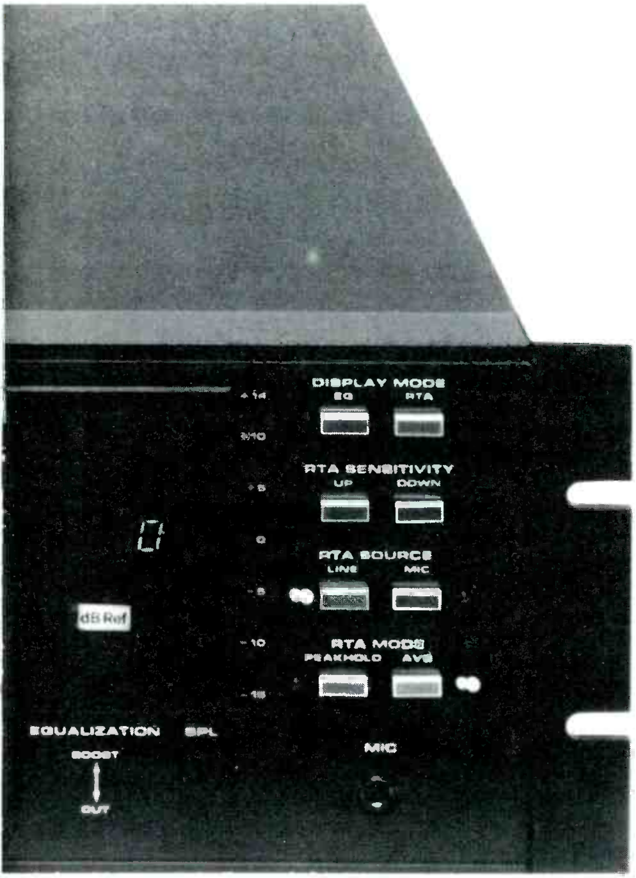


Fig. 1—Frequency responses with filters at 0 dB, each at +14 dB and also at -15 dB individually, all at +14 dB, and all at -15 dB.



The dbx 20/20 equalizer/analyzer is a sophisticated, well-thought-out combination under the control of a built-in microprocessor. The unusual, automatic equalization performed by the 20/20 is a standout achievement, even in this day of complexity and rapid change. The black front panel is quite attractive with silver-colored pushbuttons and toggles and white lettering, which also makes for excellent legibility, even in dim light. Under *Memory* there is a 3x4 array: The 10 memory buttons, *Set Flat*, and *Enter Memory*. Each memory switch has an adjacent status light to indicate if the EQ in that memory is being used. *Set Flat* will reset any EQ being used, and in the display, to zero reference level with a single push of this switch — *much* easier than trying to adjust each band manually. With *Enter Memory*, an EQ obtained manually or with the computer in use can be entered in any of the 10 memories.

Just to the left of the display is a double row of similar pushbuttons: *Auto EQ/HFR Curve*, *Average: Enter/Compute*, *Monitor: Source/Tape* and *Pink Noise: On/Off*. The *Auto EQ* button initiates the process of the computer-controlled equalization using the signal picked up by the system's microphone and with the high-fidelity system driven by the built-in pink-noise source. There is automatic checking to make certain that the pink-noise is turned on and that the level picked up by the microphone is sufficient for the auto EQ. Then, each channel of the digitally controlled equalizer is boosted or cut so that the compensating equalization makes the total system response flat, all the time keeping close to the same average level. The process stops when the response is within ±1 dB or when there have been 18 successive attempts at EQ, with a maximum time of 15 seconds — a marvel to behold. The *HFR Curve* button adds a frequency roll-off of 1 dB per octave starting at 2 kHz to any EQ displayed. This is a handy way of getting one version of a so-called house curve, somewhat corresponding to the effect of the extra absorption of the highest frequencies in a performing hall.

The averaging function of the 20/20 is one of its most interesting and important features. Perceptive listeners know there is a change in high-fidelity system performance from one listening position to another. The requirements for equalization, therefore, change as well. Some sort of average correction might be desired, but that is difficult to do manually, even with quite a few notes. With the 20/20 the corrective EQ can be stored for up to 10 different positions. With *Enter*, the user selects which of these is to be averaged by use of the *Memory* buttons; *Compute* performs the automatic averaging of all those entered. If desired, the result can then be entered into memory. It is thus quite easy to store EQ for particular individual positions as well as averages of any combinations desired. Status lights help keep track of things.

Just to the right of the display is another double row of pushbutton switches. In *EQ*, the display is of the EQ being used, whether from memory or one that has been entered manually. The levels shown in *RTA* are the result of the input selected, either line or mike, and the RTA sensitivity can be shifted in 10-dB steps over a 50-dB range. With the microphone in use, the minimum level is 45 dB (at -15 dB and 60 dB reference), and the maximum level is 124 dB (at +14 dB and 110 dB reference). The *Peakhold* RTA mode holds the maximum level in any band and in the SPL channel while it is on. *Avg* is used for the normal RTA average-responding mode, and the SPL channel is returned to its normal rms response.

The display is a 30 x 10 LED matrix with 1-dB steps from -15

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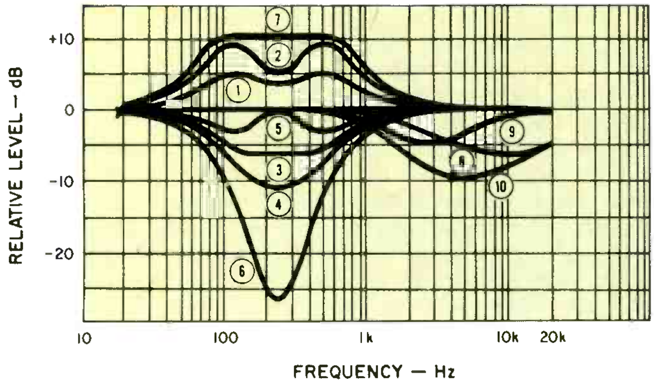


Fig. 2—Swept frequency responses with (1) 125- and 500-Hz filters at +5 dB, (2) at +10 dB, and (3) at -5 dB; (4) with 250-Hz filter also at -5 dB; (5) with 250-Hz filter shifted to +6 dB; (6) with all three filters at -10 dB, and (7) with same filters at +10 dB. Curve (8) shows HFR response, (9) 2- and 4-kHz filters at -3 dB, and (10) with HFR added.

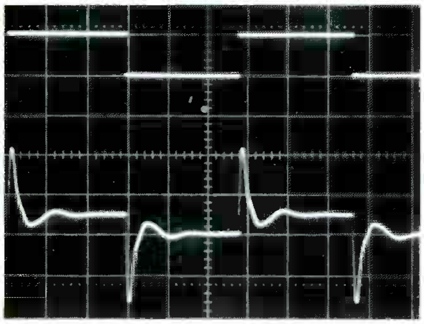


Fig. 3—Input and output waveforms with 350-Hz square wave and 4-, 8-, and 16-kHz filters at +10 dB. Vertical scale, 2 V/division; horizontal, 0.5 mS/division.

to +14 dB for each of the 10 channels, plus a single column of 30 LEDs covering the same range for the SPL channel. There is a *dB Ref* annunciator with a "0" shown for EQ mode and from "60" to "110" shown for RTA mode, depending upon the setting of the sensitivity. Each of the LEDs is a short, red horizontal bar, and all are lined up at 0 dB in EQ if *Set Flat* is pushed. Spring-loaded toggles are below the display, one for each channel. Pushing a toggle up increases the level in that channel in 1-dB steps (down for a decrease in 1-dB steps), at a faster rate if the toggle is held in longer than a few seconds. The LED bars are bright enough to be seen easily under a wide range of lighting conditions.

The power on/off switch and a microphone jack complete the features of the front panel, but it should be noted that the unit is supplied ready for rack mounting. There are stereo in/out phono jacks on the rear panel for connections to a preamp's tape monitor loop and to a separate tape recorder. There is also another mike jack, a pink-noise output jack of fixed level, the memory battery compartment, and a fuse holder.

Removing the cover of the 20/20 gives one pause in contemplating two chassis-size p.c. boards, one above the other. The top board has over *60* ICs, all in sockets, and there was a shield between the two cards. All of the parts were labeled, and the soldering was excellent. Ribbon-type cables were used between cards, including the one for the display on the back of the front panel. There was an inverted chassis with a bottom cover, making for excellent rigidity and shielding.

Circuit Description

Certain portions of this equalizer/analyzer are similar to other units. The similarity stops, however, when we consider the microprocessor system and its interfaces, particularly to the digitally controlled graphic equalizer. For those who would like to dig more deeply into the details of this unit, reference should be made to "An Automatic Equalizer/Analyzer," by Robert W. Adams of dbx, AES Preprint No. 1680 (E-3).

Measurements

The equalizer was the first section to be put under test. The center frequencies of the filters were more accurate than most, within 1% of the ISO standard in most cases. The filter shapes were very consistent from channel to channel as shown in Fig. 1. The boost/bandwidth characteristics were quite comparable to other units with a 1-octave bandwidth (Q = 1.4) obtained with an 11-dB boost; a Q of 1 was secured with a 7-dB boost.

With all of the filter sections put to maximum boost and then to maximum cut, additional swept responses were run (Fig. 1). The results are not typical, and, therefore, some explanation is required. The dbx 20/20 utilizes both series and parallel addition of filter section outputs. When the outputs combine, there is a combination of voltage and gain addition. Thus, the boost obtained with all filters at maximum is more than the 2 or 3 dB increase reported on other units. With all sections at maximum cut, another condition existed: The cut of the combination was about 25 dB in the center of the band, but it fell off greatly at the frequency extremes. A series of tests showed that at 31.5 Hz, the total cut was increased to 23 dB when the 63-Hz filter was at maximum cut along with the 31.5-Hz filter. As additional filters were put to maximum cut, however, the actual cut at 31.5 Hz was reduced. Examination of the filter phase responses showed that the shifts caused by sections more than a band away were great enough (up to 125°) to cause the reduction effect observed. The shifts are *not* as significant as they might seem immediately. It has been common practice to run responses on equalizers with all controls at maximum positions, but that is really a never-do-it condition. In fact, the dbx 20/20 can't create such a situation in its automatic mode, because the adjustments are made to keep the average around the 0-dB reference. These results do show the desirability of keeping the same type of centering for manual adjustments as well. The phase shifts with typical settings were quite acceptable.

With all filters at 0 dB, the response was within 0.3 dB from 20 Hz to 20 kHz, down 3 dB at about 100 kHz. A series of swept responses were made (Fig. 2) with several combinations of filter settings. In general, the figure captions are self-explanatory. Note the difference in curve shapes between boost and cut settings: (1) vs. (3) and (6) vs. (7). Curve (5) shows how consid-

The memory storage feature combined with the averaging function sets this unit apart from all others.

erable boost could be needed to reduce cut between two other bands. Curve (8) shows the high-frequency roll-off that can be added to any EQ with a single touch, somewhat different from the specification and the display because of filter combining. Figure 3 shows the input and output of a 350-Hz square wave with a rather unlikely setting, even in manual. The overshoot and ringing observed is a typical result for octave-band equalizers with such boosts. It is presented here as a reminder to the reader that boosts which are large (Q greater than 1.0) can cause these effects.

The input impedance was exactly to the 47-kilohm specification for most of the audio band, falling somewhat at the highest frequencies. The output impedance was a little less than the specified 470 ohms (very good), rising at the frequency extremes. The gain was within 0.1 dB of 0 dB. With various auto EQs with the pink-noise source, the overall output level was normally within 2 dB, quite good for the automatic level adjustment scheme. The maximum input/output was 7.2 V for the great majority of the band, dropping slightly at 20 Hz, to 7.0 V with a 10-kilohm load. The output polarity matched that of the input.

There was no slew-rate limiting observed with 3-V in with frequencies up to 100 kHz. The harmonic distortion was right at the specified 0.01% for most of the band, although it was slightly higher at 20 Hz. THD and noise was 0.08% with 2-V out at 100 kHz, an excellent figure. The IM distortion was less than 0.003%, rising to 0.01% just below clipping. The signal-to-noise ratio was an excellent 86 dBA with a 1-V reference.

Attention was then turned to the RTA section of the dbx unit. The peaks of the analyzer filters were within 6% of the standard ISO frequencies, and many were much closer. For the same threshold, the channel responses were very close, generally within ±0.5 dB. With pink noise fed in, the indications were within ±1 dB. With 0-dB indications in all 10 channels, the SPL channel read about 2 dB high (+12 dB). Such a discrepancy can be caused by out-of-band energy going to the SPL channel, or the "extra" energy compared to that in a channel with its peaked filter. The RTA filters are fairly peaked with crossovers to adjacent channels at about −12 dB. The thresholds for each of the 1-dB steps were very accurate in each of the channels. A change in input level of 27.3 dB was required to complete the 28 steps, an average of 0.98 dB per step, much more accurate than most such equipment.

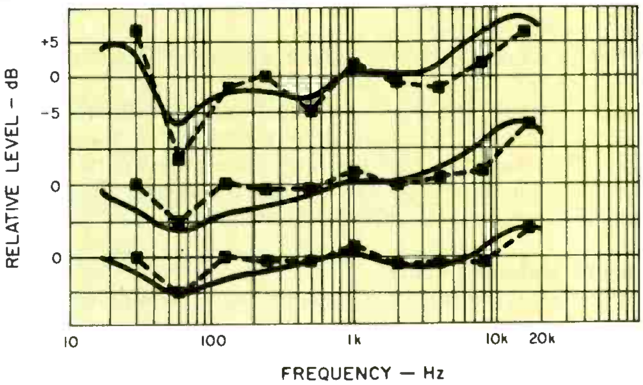


Fig. 4—Swept responses and display with EQ from Memory 1 (top), Memory 5 (middle), and Memory 6 (bottom).

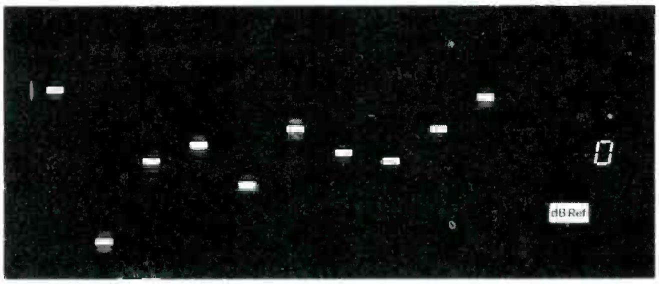
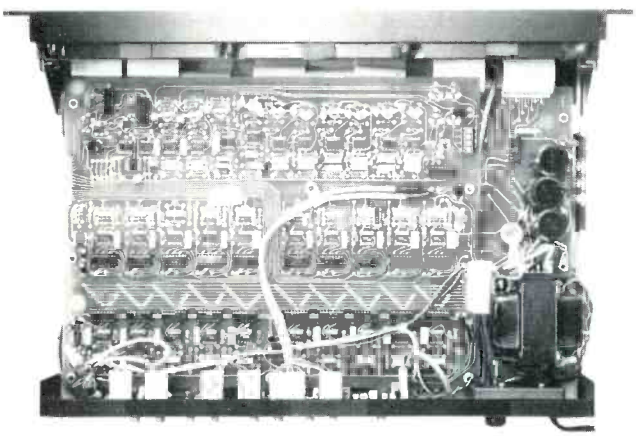


Fig. 5—dbx 20/20 with EQ from Memory 1 displayed.



The line input sensitivity was 1.07 V for a 0-dB indication at 110-dB and 3.3 mV at 60-dB zero reference. Band level was 96 dB, and SPL channel level was 108 dB with 0.9-V rms pink noise input. Each of the 10-dB steps from 60 to 110 dB were substantially exact. The SPL indications using the supplied microphone were within 1 dB of the Ivie IE-30A and Gen Rad 1933 precision-SLM reference units; this is far superior to the great majority of octave-band RTAs. There was a small rise at 16 kHz with the microphone pointed at the speaker source. In a direct field, therefore, the most accurate results would be obtained with the mike angled off to some extent, more toward grazing incidence. The microphone's 0.580-inch diameter prevents easy calibration checks, but as supplied there was no need for adjustment.

Tone-burst tests were utilized to check the dynamic responses. The SPL channel had full charge and discharge times of about 500 mS, satisfactory for most uses. In the main display, the 31.5-Hz filter had 1.5-S charge and discharge times, the 1-kHz filter had 150 mS, and the 16-kHz channel had 100 mS. The response times were the same in peak-hold mode. All of these times are generally satisfactory, although for music moni-

The dbx 20/20 is truly unique in its technology and its useful capability.

toring, faster charge and slower discharge times can be beneficial, as with a tape deck.

The pink-noise generator output was flat across the band within ±1 dB, and the sound was smooth without any recycle clunks observed. The maximum output level was 185 mV (175-mV specification), controllable down to less than a mV with the slider. The fixed output on the back panel was 47 mV, much lower than the 150-mV spec, which dbx is changing. The output impedance was very low, about 90 ohms.

Use and Listening Tests

The 32-page instruction manual includes many excellent figures, although there are some atypical EQ responses shown. The text gets a lot of essential information across very well with very good operating instructions and desirable cautions on avoiding excessive boost. Interconnections are shown for adding EQ to recording or to a pink-noise response test, but it seems that with all its sophistication and complexity, the dbx 20/20 should have included these functions as features with only a few more switches.

With the equalizer/analyzer installed in the tape-monitor loop of my system, the fascinating automatic EQ mode was used at several points in the listening area, and the results entered into the unit's memory. Figure 4 shows the results from two of the positions (Memories 1 and 5) and the application of the HFR curve to Memory 5 (stored in Memory 6). Memory 1 is the result from a location which was not considered good for listening, and the plots show a number of deficiencies. The connected-bar curve shows what appeared in the display, while the continuous-line plots show the actual EQ applied to the system. The reduction in the high-end boost when adding HFR is quite apparent in the figure, as it was to the ear. I preferred a result in between, and a slight manual adjustment achieved that purpose. Figure 5 shows the actual display of Memory 1.

Music monitoring was quite easy with the 20/20, although different time constants would have been better, as mentioned earlier. The peak-hold function was interesting to use, but a faster response time seemed appropriate for such a use. The display was always easy to read under a range of light levels. The annunciators in the display include one which informs the user when the batteries for memory hold (when the unit is off) are running low — a useful and potentially important feature. The auto equalization was always performed quickly, with automatic indications if the level from the speakers was too low or if the noise generator was not on. The memory storage feature in combination with the averaging function further sets this unit apart from all others. The price is considerable, but the dbx 20/20 is truly unique in its technology and its useful capability.

Howard A. Roberson

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