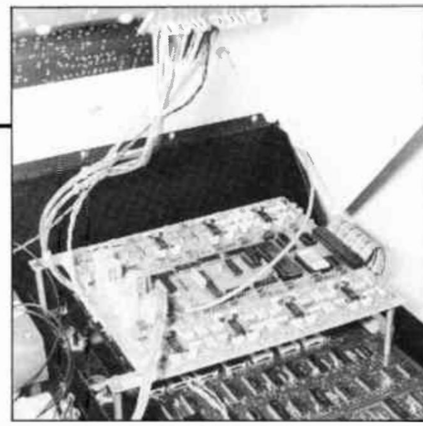
reviews

Eventide THS-224 realtime audio spectrum analyser



MANUFACTURER'S SPECIFICATION
Input: input level +14 to −20dBV for full screen display. Impedance 10kΩ unbalanced.
Filters: 31 2-pole filters from 20Hz to 20kHz, on ISO centre frequencies. Centre frequency tolerance is 3.5%. These filters do not meet ISO standards.
Absolute level: one bar of the display (LEVEL) indicates the actual level of the signal before it is bandpass filtered.
Resolution: the PET display allows 144 vertical elements. The various filter outputs are mapped on this display under software control. Assuming a 1V input signal, resolution is about 7mV in the linear display mode.
Accuracy: amplitude readout at centre frequency of each filter uniform within 1dB total from 20Hz to 20kHz, typically ±·25dB (0·5dB total), slightly decreased with higher gain.
Power and interface: obtained from host PET computer. All cables and hardware supplied.
Memory usage: analyser responds to various addresses in the $B000 through $BFFF range. Also the second cassette buffer is used for data storage, and various zero page locations are used within routines for scratchpad storage. With the exception of the second cassette buffer, no memory is stolen from the PET, and the operation of the PET is not affected in any way.
Accessories supplied: instruction manual containing schematics and detailed software usage instructions (no source listing supplied), including memory map with buffer and flag locations. Cassette with three BASIC programs; interactive operation, minimal operation and self test. All programs may be user modified. Installation kit including jumper cable, memory port cable and hardware. Keyboard overlay to define keys used in interactive program.
Price: Analyser board and kit £340 retail. PET computers from £550 to £795 for the 32K PET as used for the review.
Manufacturer: Eventide Clockworks Inc, 265 West 54th Street, New York, NY 10019, USA.
UK: Feldon Audio Ltd, 126 Great Portland Street, London W1N 5EH.

REALTIME spectrum analysers tend to be extremely expensive tools which frequently cannot be justified for studio use. However, they are very useful for checking the spectrum of audio signals and thus preparing master tapes with a suitable characteristic for disc cutting, cassette duplication etc.

The Eventide *THS-224* realtime analyser has been designed to fit into the popular Commodore PET computer systems which in their simplest form consist of a keyboard and a visual display unit (VDU). The analyser takes its power from the PET's power supplies and interfaces with the PET's digital electronics via the second cassette tape buffer in the PET's electronics.

Installation of the analyser within the PET takes only a few minutes and with the exception of occupying the second cassette buffer, the presence of the analyser doesn't interfere with the normal operation of the PET computer.

The input signal to the analyser is fed to an unbalanced ¼in jack socket which is secured at the rear of the computer. The input then passes to a variable gain amplifier, the gain of which is controlled by the computer altering the feedback around the input amplifier. From here the amplifier's output is fed to 31 filters which divide the signal into the standard ISO ⅓-octave centre frequencies from 20Hz to 20kHz. The outputs from the filters then feed halfwave peak rectifiers with an additional rectifier fed by the unfiltered output from the variable gain input amplifier.

The outputs from the rectifiers then represent a ⅓-octave analysis of the input plus an unfiltered output which represents the unfiltered and unweighted audio level.

The constant percentage bandwidth filters are based on the standard centre frequencies although the filter shape doesn't comply with the usual standards, but this doesn't matter for many applications. The rectifier outputs place a charge on a capacitor and this charge is a representation of the peak voltage output from the associated filter. No discharge resistor is fitted so the voltage is held until after each analysis, the computer then discharging the capacitor thus giving a new analysis for each scan of the filter outputs. This arrangement allows the program in the computer to alter the effective time constant of each filter. The filter and rectifier outputs are scanned by the computer via an analogue multiplexer and then fed to an A/D converter which feeds the computer with digital data related to the amplitude of the selected rectifier output.

It follows that under program control the computer can select the overall gain, any ⅓-octave for analysis, and control the rectifier time constant.

Eventide give the purchaser three programs on a cassette for operating the spectrum analysis system. **1** 'Interact', a comprehensive program allowing the analysis conditions to be altered from the computer's keyboard which is equipped with an overlay redefining the functions of various keys. **2** 'Minimal' which only allows the selection of a linear or logarithmic display, averaging or nonaveraging, and slow or fast rectifier characteristic. **3** 'Selftest', a routine for checking the correct operation of the analyser.

For normal operation the more complex program 'Interact' would be used and this allows the setting of the analysis with a choice of linear or logarithmic level display, peak hold—fast—medium—slow or very slow decay rate, normal or averaging mode. And additionally the gain may be changed in 3 or 6dB increments up or down, plus the facility for increasing or decreasing the update rate.

In the standard programmed modes, the display consists of a bar graph with the level bar to the left and the ⅓-octave bars proceeding to the right, their centre frequencies shown on the display below the bars. Lines at each side of the display act as an aid to reading the levels, but reading wasn't particularly easy to achieve accurately.

Legends at the top of the display show whether the linear or logarithmic modes have been selected, fast or slow and average or single operation.

For users who wish to develop their own programs rather than use those provided by Eventide, the spectrum analyser conversion provides 10 functions, available in the form A=USR(x). USR(1) draws the frequency and amplitude scales on the screen. USR(2) draws the bargraph of the stored data. USR(3) performs a spectrum analysis and stores the data. USR(4) sets the slow decay mode, USR(5) the fast decay mode and USR(6) the average mode. USR(7) clears the average mode and returns the number of averages. USR(8) sets a linear display, USR(9) a logarithmic display and finally USR(0) disables the analyser functions.

Normal computer instructions control the gain and the decay rate with the level data available in normal stores. It follows that it isn't difficult to program the computer to do a great variety of analysis forms in realtime without any hardware alterations. However, simple hardware changes can turn the analyser section into a 32-channel analogue input to the computer. A simple application for this would be a multichannel level display, but a

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little thought suggests many applications, not only in the sphere of audio measurements.

All three of the Eventide programs of course use the subroutines in different combinations and the 'Selftest' program has other features. This program initially checks the read-only memory for errors and then instructs the user to connect a signal generator and a frequency meter to the analyser. The user is then instructed to tune the generator to the various centre frequencies and at the end of the run the computer prints on the screen the correct frequency of each filter, the actual frequency and the percentage error. Also printed are the level amplitude, actual amplitude and percentage error with out-of-tolerance frequency or amplitude creating a message such as 'Amplitude match error this filter'.

The performance

Initial checks on the centre frequencies of all the filters showed that all were within the specification; all but five of the filters were within ±2% and the worst case was −3% thus giving a practical performance for most ⅓-octave tasks. It should, however, be noted that the filter shapes are non-standard and will not give results which correlate with ISO or ASA standard ⅓-octave filters when measuring noise.

The frequency response of the system varied substantially with the gain setting and whilst the manufacturer mentions this matter in the instruction manual I feel that the high frequency deviations are excessive. At minimum gain the unfiltered bar had −3dB points at 3Hz and 150kHz with the overall display within ±0.25dB which is quite satisfactory. However at maximum gain the −3dB points for the unfiltered bar became 3Hz and 5.9kHz which can only be described as a poor performance with the display showing the following errors, **Table 1.**

To give an idea of the relation between frequency response and gain the error at 20kHz was checked at 6dB and 12dB less than maximum gain, with the respective errors −6dB and −2dB which suggests that the manufacturer would have been wise to limit the gain to 12dB less than the existing gain.

Another factor that would also improve is the input overload margin which was satisfactory at minimum gain with 20dB in hand reducing to 8dB at maximum gain.

The use of random noise in frequency response analysis needs some caution, as low frequency response errors occur to the extent of 4/6dB in the slow modes with only the average and peak mode giving correct results within ±1.5dB for pink noise.

Table 1

Frequency	2·5kHz	3kHz	4kHz	5kHz	6kHz	8kHz	10kHz	12kHz	16kHz	20kHz
Error (dB)	−0·25	−1·5	−2·5	−4	−5	−6	−7·5	−9	−11	−13

Table 2

Gain Min	+6dB	+12dB	+18dB	+24dB	+30dB	+36dB
Increment	6·1dB	5·9dB	6·2dB	6·4dB	7·7dB	10·3dB

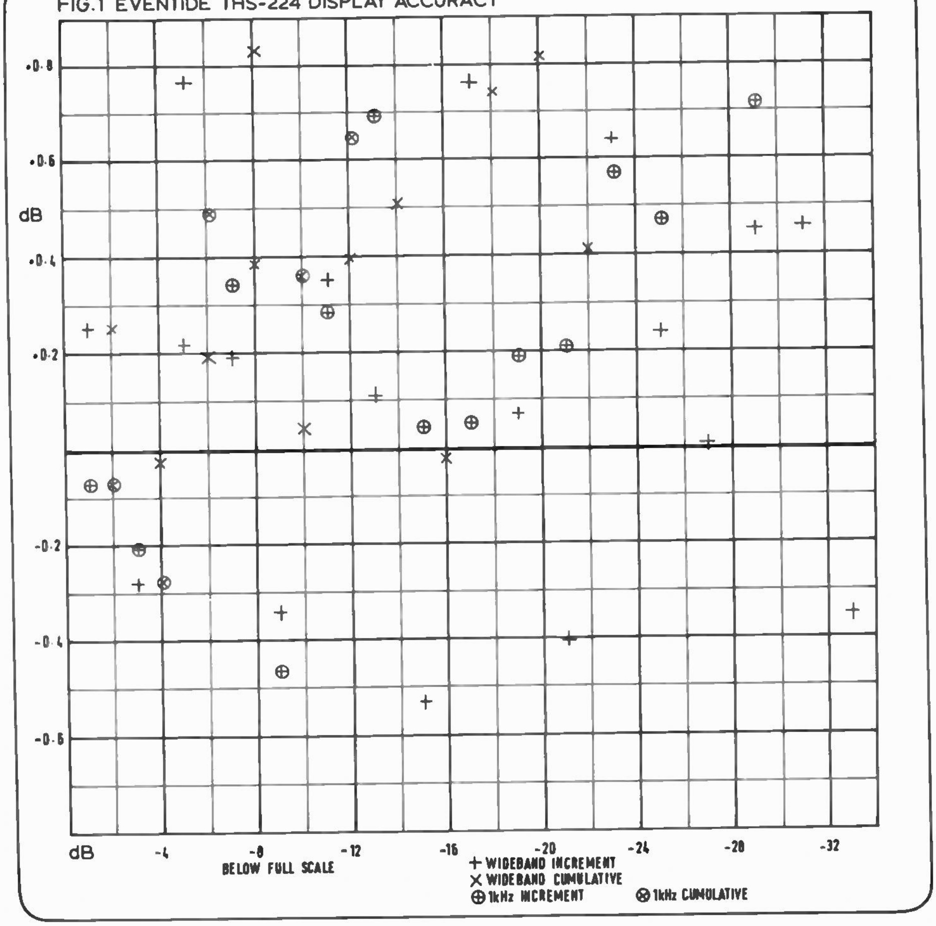

FIG.1 EVENTIDE THS-224 DISPLAY ACCURACY

Using the logarithmic display mode the input sensitivity was 4V rms at minimum gain, rising to 13.4mV at maximum gain with a satisfactory input impedance of 9.4kΩ in parallel with 100pF.

Checking the accuracy of the nominal gain increments of 6dB and 3dB gave the following results **(Table 2)** which suggest some non-linearity in the analogue multiplier which controls the input gain.

The 3dB gain increments showed a similar pattern with increasing step errors at higher gains.

The ⅓-octave bands had no problem with noise, but the wide band bar gave a noise reading of −22dB below full scale at maximum gain.

Investigations into the attack and fall times of the ⅓-octave bars showed that they were all similar, the effective attack time remaining constant with the various decay time settings at about 5ms to reach the full steady state level when fed from a tone burst.

In the 'fast' mode the fall time to the bottom of the logarithmic scale was 600ms increasing to 4s in the medium mode, 8s in the slow mode and 24s in the very slow mode, thus giving a very useful range of computer-controlled decay times with the added valuable facility of the peak hold function.

The display, which in the logarithmic mode has a dynamic range of 36dB, is divided into 2dB sections at either side of the bar graph with a maximum resolution of 0.25dB resulting from the 144 vertical display elements. Checking the display for incremental accuracy at 1kHz and in the wide band bar, and also for cumulative errors produced **fig 1.** This shows, allowing for reading difficulties, that the incremental accuracy within any 2dB step was better than 0.72dB at 1kHz, with cumulative errors of less than 1dB down to a −14dB indication. The accuracy of the wide band bar wasn't all that different and the overall display accuracy was quite adequate for most purposes.

Summary

This is a review of the Eventide *Spectrum Analyser* rather than the PET computer, but I must mention that the PET uses the 'Basic' programming language which is very easy to learn. Therefore, even if you don't have any experience of computers don't be put off by the PET. It's great fun to play with and apart from playing games it can be interfaced to many peripheral devices so you can do the mundane tasks of writing invoices and stock keeping plus other audio measurements with interfaceable instruments.

The realtime analyser is an extremely useful device for many audio applications, and mostly great accuracy is completely unnecessary and other than the high gain frequency response errors the Eventide module is quite adequate.

I feel that Eventide could quite easily overcome this problem and that they should warn users about the potential snags when using random noise with the analyser.

Overall, this is an inexpensive and versatile piece of equipment which can be simply programmed to undertake complex analysis in realtime—I'm sorely tempted to keep it.

Hugh Ford