A VOICEBAND HYBRID CCD - ACTIVE FILTER FOR TELECOMMUNICATION APPLICATIONS

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SUMMARY

In this paper, we present a low-pass filter for the telephone band. It uses a hybrid structure, combining a CCD circuit with two active second-order filters. Figure 1 shows the device schematically : it has two identical filters, for two parallel telephony channels (emission and reception). Each channel consists of a second-order active filter for anti-aliasing pre-filtering followed by the CCD filter, and finally by another second-order active filter for post-filtering and clock-frequency rejection. A CMOS circuit derives the necessary clock signals from a 128 kHz master clock, and distributes them to the filter circuits. The supply voltages are limited to ± 5 V for the CMOS, + 12 V for the CCD and ± 12 V for the active filters.

The advantages of this new design are that the second-order pre- and post-filtering provide very effective anti-aliasing filtering and smoothing, as well as contributing to the filtering due to the CCD. This greatly simplifies the CCD design as it only consists of a transversal filter with 19 coefficients, all of which are positive ; the readout circuit is thus greatly simplified.

The surface area of the CCD part is thus reduced, the two channels only occupying 9 mm^2. The manufacturing yield of this delicate part is thus greatly improved with respect to that of a conventional design in which a minimum of 70 coefficients are required (for the same filter characteristics.

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but for a clock frequency only half as big which, in addition, is unfavorable for anti-aliasing). Another advantage is that a low output impedance (600 Ω) is obtained because of the active output filter.

The performance obtainable with these devices is summarized below :

input level : -12 dBm at 600 Ω (CCD input level : 1.5 V_{pp})
output level : +12 dBm at 600 Ω (CCD output level : 2 V_{pp})
harmonic distorsion at 800 Hz :
< -46 dB (-62 dB at the CCD) for H_2 / H_1
< -46 dB (-56 dB at the CCD) for H_3 / H_1
dynamic range : 85 dB (noise being measured around 1900 Hz with a 1740 Hz bandwidth)
power dissipation : 70 mW for 2 filters (8 mW at the CCD)

Figures 2 and 3 show the frequency (rejection better than 40 dB beyond 4600 Hz) and distorsion performances. Figure 4 shows the pass-band ripple performance (< 0.05 dB) and the dispersion over 12 samples (< 0.075 dB).

The interchannel crosstalk of this device is on the order of -70 dB. Coupling two filters of this type in series, and driving them with synchronous clock signals permits obtaining an out-of-band rejection of better than 84 dB from 4600 Hz, while conserving the 85 dB dynamic range mentioned above.

CONCLUSION

These results demonstrate the interest of second-order-filter/CCD combinations. Such filters have been made for PCM channels, and have operated very satisfactorily.

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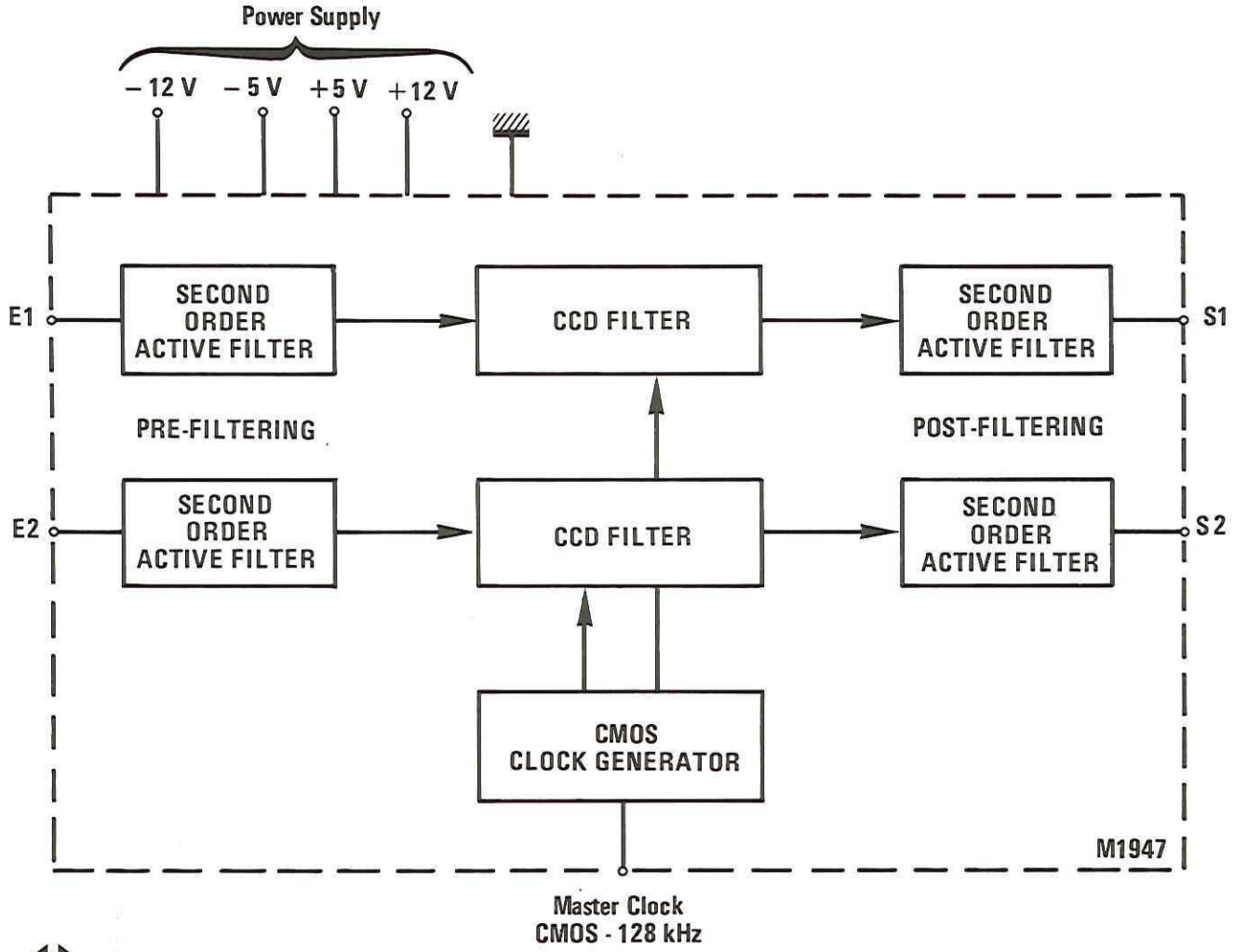

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FIG. 1 – M 1947 HYBRID CCD-ACTIVE VOICE BAND FILTER

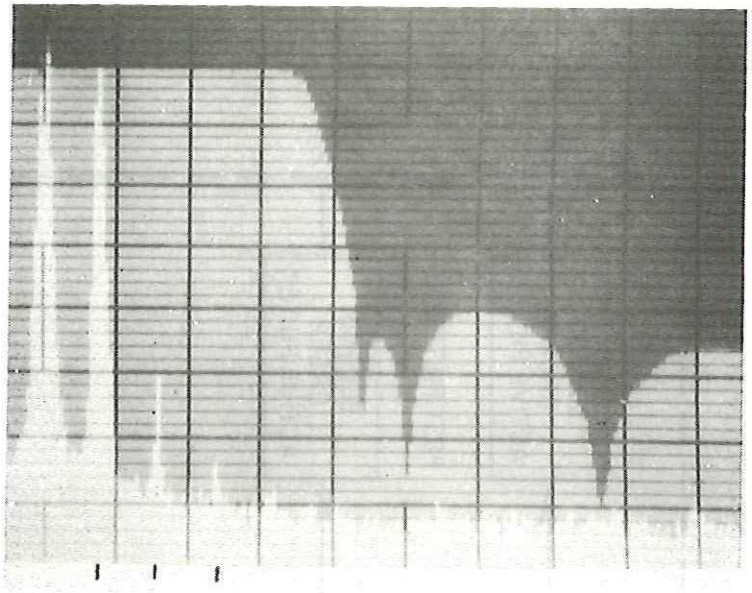

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FIG. 2 – FREQUENCY RESPONSE AND HARMONIC DISTORTION

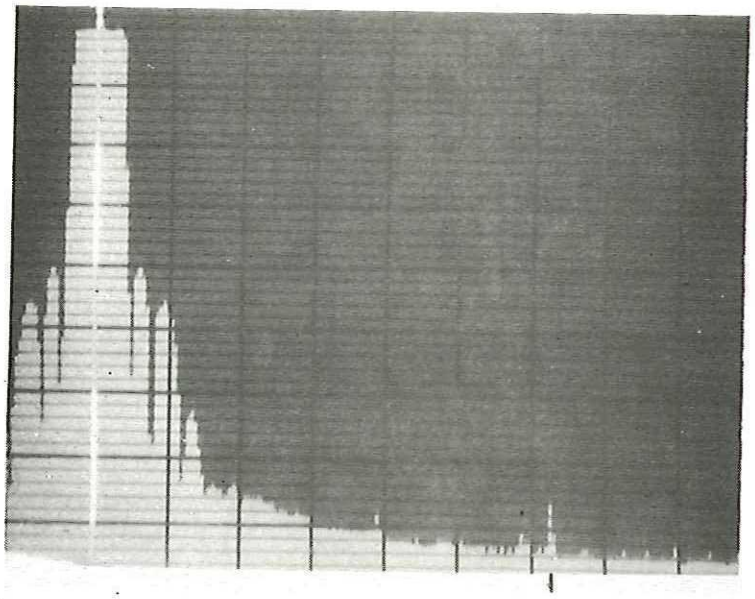

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FIG. 3 – STOP BAND ATTENUATION (> 40 dB) AND REJECTION OF CLOCK FREQUENCY (– 76 dB)

FIG. 4
DISPERSION IN THE FREQUENCY RESPONSE CURVES OVER THE PASS BAND FOR TYPE TH X1123-82 DEVICES