

Fig. 12. A 5 MHz isolation amplifier.

gain) with PM noise of $\mathcal{L}(10 \text{ Hz}) \leq -162 \text{ dBc/Hz}$. AM and PM noise in CC and CB configurations was also studied. Due to their small phase shift and small gain, these stages have very low $1/f$ AM and PM noise. Our 5 MHz CC amplifier had noise levels similar to the noise floor of the measurement systems [$\mathcal{L}(10 \text{ Hz}) \leq -169 \text{ dBc/Hz}$, $1/2S_a(10 \text{ Hz}) \leq -162 \text{ dBc/Hz}$]. In addition, our 5 MHz distribution amplifier (composed of 3 CB stages) had noise levels of $\mathcal{L}(10 \text{ Hz}) \leq -168 \text{ dBc/Hz}$, and $1/2S_a(10 \text{ Hz}) \leq -160 \text{ dBc/Hz}$.

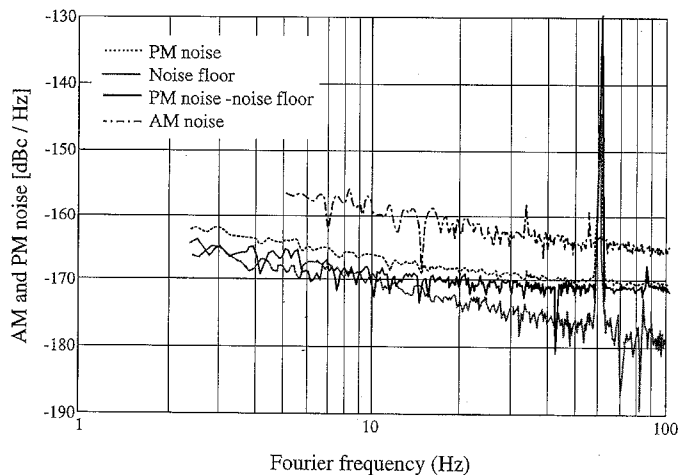


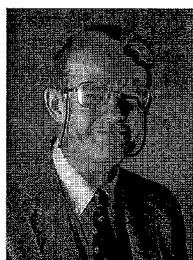
Fig. 13. PM and AM noise for an isolation amplifier at 5 MHz.

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REFERENCES

- [1] F. L. Walls, E. S. Ferre-Pikal, and S. R. Jefferts, "The origin of $1/f$ PM and AM noise in bipolar junction transistor amplifiers," *Proc. IEEE Freq. Contr. Symp.*, 1995, pp. 294-304.
- [2] D. Halford, A. E. Wainwright, and J. A. Barnes, "Flicker noise of phase in rf amplifiers and frequency multipliers: characterization, cause, and cure," *Proc. 22nd Ann. Freq. Contr. Symp.*, 1968, pp. 340-341.
- [3] S. G. Andressen and S. K. Neheim, "Phase noise of various frequency doublers," *IEEE Trans. Instrum. Meas.*, Vol. IM-22, pp. 185-188, June 1973.
- [4] A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, New York: Oxford Univ. Press, 1991, pp. 573-576.
- [5] R. S. Muller and T. I. Kamins, *Device Electronics for Integrated Circuits*, New York: Wiley, 1986, pp. 190-193.
- [6] F. L. Walls, S. R. Stein, J. E. Gray, and D. J. Glaze, "Design considerations in state-of-the-art signal processing and phase noise measurement systems," *Proc. 30th Ann. Freq. Contr. Symp.*, 1976, pp. 269-274.
- [7] W. F. Walls, "Cross-correlation phase noise measurements," *Proc. 46th Ann. Freq. Contr. Symp.*, 1992, pp. 257-261.
- [8] C. W. Nelson, F. L. Walls, M. Sicardi, and A. De Marchi, "High isolation distribution amplifier at 5 MHz and 10 MHz," *Proc. 48th IEEE Freq. Contr. Symp.*, 1994, pp. 567-571.



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