Novel 70-MHz Limiting Amplifier

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A high-speed digital differential comparator has been successfully utilized as the limiting element in an RF module operating in the VHF region. The device exhibits good amplitude and phase characteristics. This article describes the design and test results of the device, which uses emitter-coupled logic as a limiting amplifier.

I. Introduction

At various DSIF stations, both the receiver/exciter and the antenna microwave subsystems utilize RF modules which are electrically connected but are physically separated from each other. This occurs because some modules must be located in a control room area while others must be installed in antenna-mounted assemblies. Separation distance depends upon the particular station, and may vary from approximately 100 to 500 meters. In the frequency range used, 40 to 100 MHz, the corresponding insertion loss of the RF cables connecting the modules varies from 3 to 10 dB or more depending on the type of cable used.

It is desirable to design the modules involved to accept, without realignment, input power variations associated with the different cable losses at each station. This article describes the design and test results of a broadband wide range limiter which uses emitter-coupled logic (ECL) as a limiting amplifier.

II. Design Requirements

To accommodate all installations, the limiter must operate with an input power variation of at least 15 dB. The limiter output power must not vary more than 0.5 dB over the 15-dB input power range, and the input range must be compatible with the maximum output power capabilities of most modules, namely +10 dBmW maximum. In addition, the phase delay of the limiter must not change more than a few degrees per dB input change over the power range. Finally, the above performance must be obtained over the frequency range of 40 to 100 MHz.

III. Design Concept

Within the digital logic families are differential comparators which offer an effective limiting function because the two levels associated with the output states are dependent upon the relative logical condition of the inputs and not upon the absolute level of the input signal. High-speed comparators are available and can operate easily

in the 100-MHz region. In fact, ECL devices typically exhibit sub-nanosecond switching times.

There are several lines of ECL which are suitable for this application. While not necessarily the best choice for all applications, the design of the limiter tested and reported here utilizes an MC1650, MECL III comparator.

IV. Configuration

Figure 1 shows the configuration which was tested at 40, 70, and 100 MHz. Because of the low output impedance of the MECL comparator, no matching was used between the comparator and the single stage, class A output amplifier. The amplifier offered enough harmonic rejection to make the output waveform essentially sinusoidal without additional filtering.

V. Results

ECL limiter performance at 70 MHz is presented in Fig. 2. Temperature effects are not plotted, but produce a shift in the power curve of less than 0.02 dB per degree centrigrade. The temperature effect on phase is approximately 0.2 degrees per degree centigrade. Curves at 40 and 100 MHz are not presented because they are essentially identical to the curves shown.

VI. Conclusions

The amplitude curve in Fig. 2 clearly shows a device with excellent limiting characteristics over a dynamic range greater than 20 dB. Low level leakage and a region of linear operation are also apparent in the curve, but these areas are well outside of the operating region.

The phase slope is smooth in the operating region, and has a slope less than 3 degrees per dB at the worst point. The phase exhibits some wildness when the input is overloaded, but this point can be controlled by changing the input attenuator.

The device meets the requirements set forth and provides a simple means of obtaining a good limiter in the VHF region.

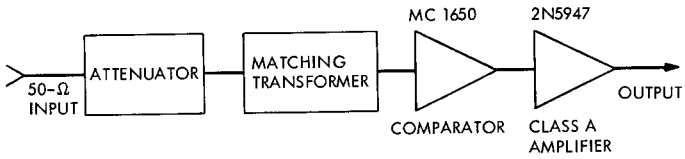

Fig. 1. Limiter configuration

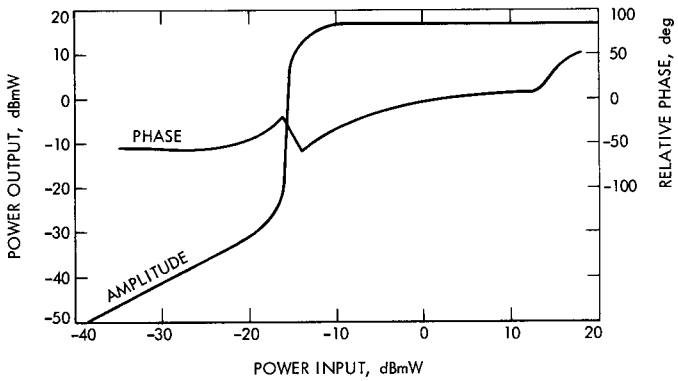

Fig. 2. Limiting amplifier performance at 70 MHz