UHF Frequency Selective Limiters

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Abstract — **A frequency selective limiter, based on magnetostatic surface wave propagation in a GaScYIG film, is described. Small signal insertion loss was 10dB and the threshold power level was –25 dBm over the 400 MHz to 800 MHz frequency range. Small signal attenuation and intermodulation products, resulting from the interaction between two signals, are only significant if the signals are less than 10 MHz apart. Similar devices are expected to be used to extend the dynamic range of broadband receivers.**

I. INTRODUCTION

Large interfering signals can prevent the detection, by a broadband receiver, of small signals of interest. Significantly increasing the receiver dynamic range, to accommodate the large signal without saturation, is likely to result in significantly increased cost and power dissipation. YIG frequency selective limiters (FSL) can provide a cost-effective solution, in some situations, with negligible increase in power. Stripline FSLs, fabricated using thick YIG films, have been described previously [1] and are suitable for broadband, microwave applications. Here a FSL operating in the 400 MHz to 800 MHz frequency range is described with frequency selectivity and threshold power levels 100 times lower than achieved with stripline devices. Signal-to-noise-enhancers using a pair of MSW FSLs have been demonstrated [2] for noise reduction in DBS TV receivers and a similar MSW FSL configuration was used here.

Magnetostatic surface wave (MSW) propagation at UHF requires a significant reduction in the 4πM and anisotropy fields of the YIG film. Suitable characteristics were achieved with GaSc substituted YIG films [3] grown by liquid phase epitaxy (LPE).

I. UHF FSL DEVICE

The UHF FSL was designed around a 5 μm thick GaScYIG film with a 4πM of approximately 800 Gauss and is shown in figure 1. The transducers were 1 cm long microstrip lines on a 25 mil thick alumina substrate and were separated by 6 mm. Lumped element matching circuits can be seen in figure 1, and provided a return loss of greater than 15 dB over the 400 MHz to 800 MHz frequency range. The magnetic bias field of approximately 10 Oe. was provided by a ferrite magnet

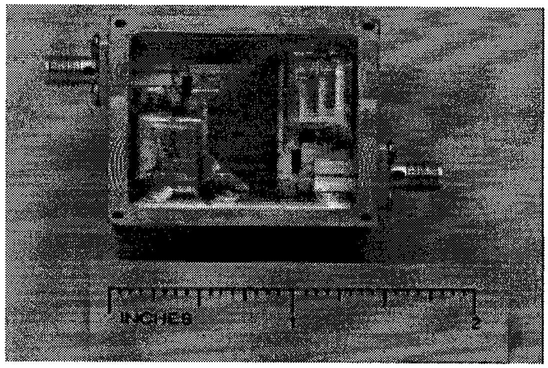

Figure 1. Interior of UHF FSL showing GaScYIG film, microstrip transducers and matching circuits.

located under the GaScYIG film. This device showed a small signal insertion loss of approximately 10 dB over the 400 MHz to 800 MHz range.

II. LIMITER PERFORMANCE

The measured insertion loss variation with frequency is shown in figure 2 with the input power level as a parameter. The threshold power level is approximately -25 dBm and is uniform across the bandwidth of the device. The FSL is linear at input power levels below threshold and provides an approximately constant output power level for input powers above threshold. The limiting performance is well behaved for inputs up to 10 dB above threshold. However, at higher input power

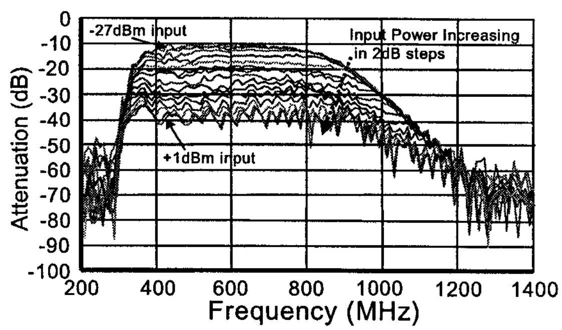

Figure 2. FSL attenuation verses frequency with the input power level increasing in 2dB steps from –27dBm to +1dBm.

levels, the limited signal interferes with direct input/output leakage resulting in variations in the output power.

III. Multiple Signal Interactions

The frequency selectivity of a limiter is a measure of the effect of a large signal on the attenuation of a small signal. This is the feature that distinguishes the YIG FSL from other limiters. The measured output power of a small, -40 dBm, input signal is shown in figure 3 verses the offset frequency of the small signal from a large above threshold signal. The 3 dB bandwidth of the small signal attenuation notch, increases with increasing large signal power level and is less than 2 MHz for power levels <-15dBm.

Multiple input signals produce third order intermodulation products that are of major concern in the design of high dynamic range, broadband receivers. However, as can be seen from figure 4, the power level of the intermodulation products decrease rapidly with increasing frequency offset between the two signals. For power levels less than 10 dB above threshold, the intermods are negligible at offset frequencies greater than a few MHz. The variation of the intermod output power with offset signal input power is shown in figure 5.

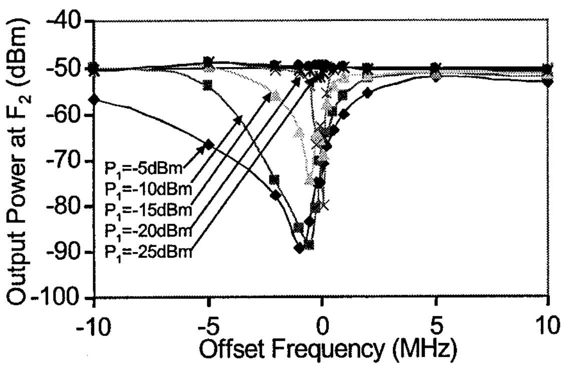

Figure 3. Output power, for a small signal at F_2, verses offset from a large signal F_1 at 600MHz. The input power level (P_1) of the large signal was varied in 5dB steps between –25dBm and –5dBm. The small input signal power level is –40dBm.

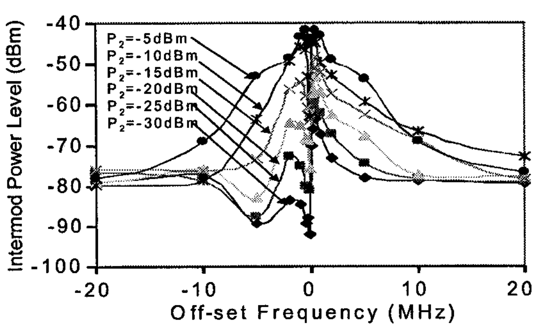

Figure 4. Variation of intermod power level with frequency offset for two input signals. F_1 was set to 600MHz with power level (P_1) = –5dBm. The input power level (P_2) of the offset frequency (F_2) was varied from –30dBm to –5dBm in 5dB steps.

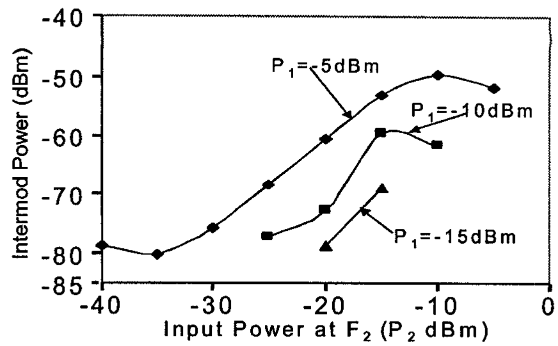

Figure 5. Output intermod power level verses input power level at F_2 with the power level at F_1 as a parameter. F_1 was set at 600MHz and the offset between F_2 and F_1 was –10 MHz.

IV. Conclusion

Uniform limiting over the 400 MHz to 800 MHz frequency range has been demonstrated with a MSW FSL using a GaScYIG film. The threshold level was –25 dBm and interactions between two simultaneous signals are only significant if their frequency separation is less than 10 MHz. These devices are expected to find application in extending the dynamic range of broadband receivers.

Acknowledgement

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References

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[3] "Magnetostatic Waves in Weakly Anisotropic Ga, Sc-Substituted Yttrium Iron Garnet Films", S. L. Vysotskiy, et al. Radiotekhnika i elektronika, no. 6, pp. 1086-1095, 1992.