the long state). At the maximum housing temperature of 150°F, corresponding to 350 W of incident average power, the change in insertion phase was only 20°. When, in addition to conduction cooling, air convection was permitted, these temperature and insertion phase excursions were not reached until the average power exceeded 500 W.

In conclusion, we have described a method of fabrication for nonreciprocal ferrite (garnet) phasers which should be capable of yielding very uniform electrical characteristics in production. Using quantity manufacturing techniques, such as die-casting and sheet-metal stamping for fabricating the waveguide housing and tunnel-kiln sintering for producing short (i.e., 3-in) toroids, this fabrication method could yield reproducible high-figure-of-merit phasers at low cost. In addition to low cost, another attractive feature of die-casting is the ability to manufacture waveguide housings with thick walls for high average power applications. Die-cast techniques for producing a waveguide channel, with an auxiliary stamping process for manufacturing the waveguide lid, have been investigated, and a successful production run of 300 housings has been made.

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Letters

Comments on "Applications of Time-Domain Metrology to the Automation of Broad-Band Microwave Measurements"

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At the suggestion of E. H. Fooks of the University of New South Wales in Australia, we would like to comment on the errors involved in the time-domain metrology measurement techniques[1] as applied to measuring the electrical properties of materials. Mr. Fooks pointed out that the negative values of μ_r'' which are given in fig. 8 produce amplification of the signal. Obviously some experimental error is present.

At the high-frequency end of the spectrum, the errors are caused by the decrease in the signal-to-noise ratio as demonstrated by fig. 3. At the low-frequency end of the spectrum, there are two significant sources of error. First, the sample size becomes a small fraction of a wavelength so that the reflected energy at low frequencies is small. Second, the time window may be truncated before the recorded signal has reached its final value. For the spectrum of the measurement presented in fig. 8 these extremes are estimated to occur above 8 GHz and below 0.8 GHz, respectively. In the intervening region, it has been estimated that the values presented are accurate to within an absolute value of 0.1 of the measured value. Since it is well known that $\mu_r'' > 0$ and $\epsilon_r'' > 0$, one can only conclude from fig. 8 that $|\mu_r''| < 0.1$.

Clearly, the particular time-domain method described is better suited to accurate loss tangents measurements on high-loss materials than on low-loss materials. It has been usefully applied to lossy dielectrics and ferrites. Other time-domain methods for low-loss materials are currently under study.

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