INTRODUCTION

Many devices such as oscillators and amplifiers need to be tested for their behaviour under different load conditions. Thus the variable load impedance (VLI) is a test device that produces variable impedances for these test purposes. It consists of a coupler, band-pass filter, phase shifter, variable attenuator and an amplifier.

The variable load impedance device uses an active feedback loop, samples a signal from the output of a device under test (DUT), processes that signal and then reinjects the signal into the DUT’s output port thus emulating a controlled impedance load. The impedance is controlled by conditioning the input signal’s phase and amplitude.

THE VLI SETUP

The coupler used is a 5dB branch line coupler. When the signal reaches the coupler at the input port, it goes through two paths, i.e. the coupled port and the through port. The coupled port is used to connect the coupler to the filter and hence represents the forward path of the signal through the coupler. The matched load absorbs the signal at the through port in the forward path and the isolated port is terminated by 50Ω matched load and hence absorbs any signals there. After the signal is conditioned, it is fed back into the coupler at the coupled port making it the new input port. The through signal goes into the DUT and the matched load absorbs the coupled signal. This represents the reverse path. Therefore the purpose of the coupler is to provide a path for the outgoing signal into the rest of the circuit and a path for the incoming signal back to the DUT.

The Band-pass Filter

The band-pass filter is used to prevent the circuit from oscillating by ensuring that the feedback signal does not have sufficient strength to cause oscillations in the amplifier. When the signal is fed back into the coupler, the port where the filter is connected becomes the isolated port. The coupler is designed so that at the design frequency, negligible signal comes out of this port, thus a filter at this port will prevent signals which might have sufficient strength at other frequencies from going into the circuit, hence there would be no oscillations.

The Phase Shifter

The phase shifter is used in the circuit so that the phase of the signal can be varied. Varying the phase of the signal allows the impedance to be varied. Thus at a particular magnitude, different phase shifts mean different impedances.

The Variable Attenuator

The variable attenuator is used to vary the magnitude of the signal, which also provides varying impedances. Thus a variable attenuator in conjunction with the phase shifter allows the impedance to be controlled precisely and also provides a wider range of load impedances.

The Amplifier

The amplifier is used in the circuit to amplify the signal so that losses that occur in the circuit are compensated. These losses occur in the individual components as well as the overall circuit. The coupler has a loss of approximately 5dB with around 1dB losses in the other components, thus the total loss is approximately 6dB. The amplifier designed has a gain of approximately 12dB, hence all the losses are compensated as well as providing some signal gain.

The Reflection Coefficient, \( \Gamma \)

The reflection coefficient of the signal that is fed back into the DUT is the ratio of the reverse to forward voltage and is given by \( \Gamma = b/a \). When this is plotted on the Smith chart, the exact impedance is obtained. If \( \Gamma \) is greater than 1, this represents an impedance that has a negative real part. This impedance then maps outside the Smith chart and in order to find the impedance value, \( 1/\Gamma \) is plotted on the Smith chart and the resistance circles are taken as being negative and reactance circles as labeled.

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The Amplifier

The amplifier is used in the circuit to amplify the signal so that losses that occur in the circuit are compensated. These losses occur in the individual components as well as the overall circuit. The coupler has a loss of approximately 5dB with around 1dB losses in the other components, thus the total loss is approximately 6dB. The amplifier designed has a gain of approximately 12dB, hence all the losses are compensated as well as providing some signal gain.