JEDEC STANDARD

Measurement of Small Signal HF, VHF, and UHF Power Gain of Transistors

JESD306

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MAY 1965 (Reaffirmed: April 1981, April 1999, March 2009)

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

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EIA RS-306

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Engineering Department

ELECTRONIC INDUSTRIES ASSOCIATION

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MEASUREMENT OF SMALL SIGNAL HF, VHF, AND UHF POWER GAIN OF TRANSISTORS

(This Standard was formulated under the cognizance of JEDEC Commitee JS-9 on Industrial Transistors)

INTRODUCTION

The transistors shall be tested in the general circuit shown in Figure 1.

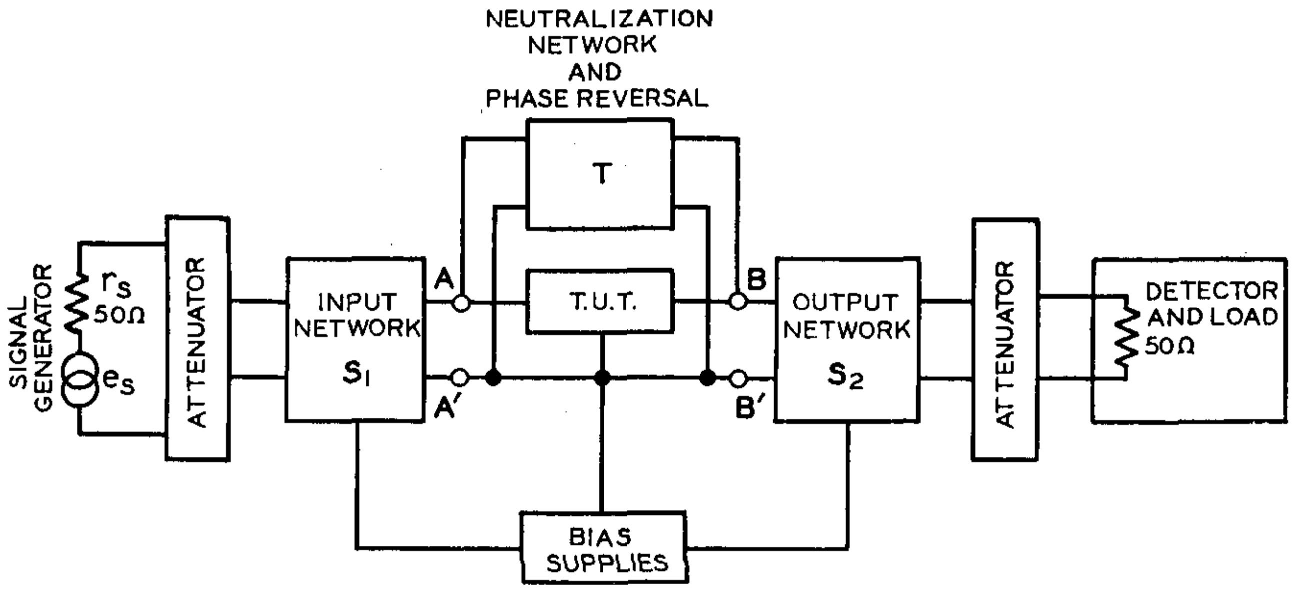


FIGURE 1

The generator shall have an output impedance of 50 ohms. The attenuator shall be designed to work in a 50 ohm line. The detector and load shall have a 50 ohm input impedance. Network S_1 shall be a single-tuned network designed to operate from a 50 ohm source. Network S_2 shall be a single-tuned network designed to operate with a 50 ohm load. Network T is a neutralization network and should be used if specified. The common terminal and the operating biases of the transistor under test shall be specified. Good engineering practice must be used in bypassing bias supplies, shielding individual portions of the circuit, and in minimizing the effects of ground currents.

The test circuit for the transistor shall be constructed such that it follows in form the specified test circuit, and it shall have values approximately equal to the nominal values specified for the test circuit.

NETWORK S_1

Network S_1 shall be so designed that it, in conjunction with the input impedance of the transistor, has a single resonant frequency. It will usually have one or more variable elements which determine the resonant frequency. S_1 may or may not provide an impedance transformation between the signal generator and the transistor under test. If the power gain measurement is specified as a fixed source impedance measurement, then S_1 may either be a parallel network whose conductance (with the signal generator connected to the input) as presented to the transistor terminals does not vary with any variable elements in S_1, or it may be a series network whose resistance as presented to the transistor terminals does not vary with any variable element in S_1. Network S_1 shall be made as nearly lossless as possible.

Network S_1 shall be so designed that with a fixed specified dummy load connected across its output terminals in place of the transistor under test, it shall have, when tuned to center frequency, a specified loss and bandwidth if it is a "fixed source" network. If it is a "variable matched" network, then it shall be so designed as to have a specified loss and bandwidth when connected to each of two fixed specified dummy loads and adjusted for maximum power transfer at the specified center frequency. The variation in the settings of the tuning and matching networks for the two specified dummy loads determines allowable limits of the tuning network.

NETWORK S_2

Network S_2, in conjunction with the output impedance of the transistor, shall be a single-tuned network meeting the same requirements as network 1. When connected to the load and driven from a specified dummy source, it shall have the specified loss and bandwidth (specified for two-different dummy source impedances if a "variable matched" network). The variation in the settings of the tuning and matching networks for the two specified dummy loads determines allowable limits of the tuning network.

NETWORK T

Network T shall be included only for measurements of neutralized power gain. If the measurement as specified is a "fixed neutralized" measurement, then T shall have no variable elements and shall be so constructed that with the transistor under test removed, a specified dummy load connected between terminals A and A′, a specified dummy source connected between terminals B and B′, and with a specified impedance connected between terminals A and B, and with networks S_1 and S_2 tuned to center frequency, the reverse attenuation between the load terminals and the signal generator terminals shall be greater than a specified amount.

For "variable neutralization" power gain measurements, network T shall be constructed as specified.

GENERAL COMMENTS ON NETWORKS S_1, S_2, AND T

Networks S_1, S_2, and T shall be constructed to have a minimum of parasitic capacitance, shall be shielded from one another, and shall be constructed using good engineering practice. In general, an attempt should be made to construct these networks such that any unavoidable parasitic elements are included in the specified parts of the network.

TYPICAL FORMS OF NETWORKS S_1, S_2, AND T

Typical network forms which meet the requirements of S_1, S_2, and T are shown in Figure 2. These are given only as a guide and not as a comprehensive list of all of the networks which will meet the requirements.

METHOD OF MEASUREMENT

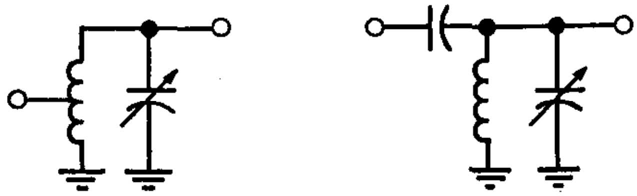
The signal generator and the load are connected as shown in Figure 1. The signal generator is set to the center frequency, and networks S_1 and S_2 are adjusted to provide maximum output. The adjustment must be such that if the signal generator is tuned either upward or downward from center frequency the output power will decrease.

If a "variable neutralization" measurement is being made, network T may be adjusted in either one of two ways.

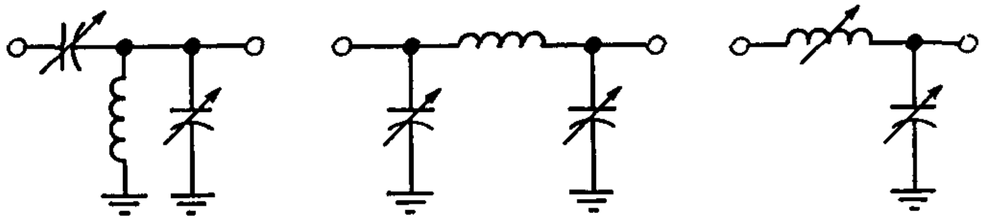
(a) The signal generator and the detector shall be interchanged, the attenuators set for zero attenuation, and network T adjusted for minimum power transfer from output to input. The stage shall be considered to be neutralized if the sum of the forward and reverse gain is less than —20 db if the center frequency is below 500 mc, or —10 db if above 500 mc.

(b) The signal generator at the input may be replaced with a 50 ohm sweep generator adjusted to provide a swept input frequency which traverses the normal bandpass characteristic of the test circuit. A high impedance detector is placed across the input to network S_1, all attenuators are adjusted to 0 db and network T is adjusted such that minimum perturbation is observed on the detector when the output load is alternately shorted and unshorted. When the neutralization is adjusted in this fashion, the reverse attenuation criteria stated above must still be met.

S_1 Fixed Match:



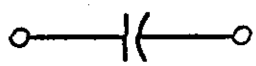
S_1 *Variable Match:*



S_2 Fixed Match: Ditto S_1 (Interchange Input and Output)

S_2 Variable Match: Ditto S_1 (Interchange Input and Output)

T Fixed Neut.:



T Variable Neut.

FIGURE 2 — TYPICAL S_1, S_2, AND T NETWORKS

The adjustment criteria for networks S_1, S_2, and T must be simultaneously achieved. This will mean that in some cases an iterative procedure must be used to adjust these networks. At all times during the adjustment of the network the signal levels must be kept small enough so that the amplifier is operating in its linear range.

The power gain measurement shall be made by a substitution method. The signal generator is connected directly to the detector. The signal generator is set for a convenient output and the detector level noted. The signal generator and the detector are then connected to the test circuit and the attenuators adjusted (without changing the signal generator level) so that the detector reads the same reference level. The power gain is then equal to the sum of the attenuation of the input and output attenuators (it is desirable to have all of the attenuation in the input circuit in order to keep the operating level of the amplifier as small as possible, however, this may reduce the signal level sufficiently so that noise may upset the accuracy of the measurement. In this case it is desirable to place some of the attenuation in the output circuit).

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