

JEDEC STANDARD

Standard for the Measurement of Small-Signal Transistor Scattering Parameters

JESD435

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION



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EIA STANDARD

STANDARD FOR THE MEASUREMENT

OF SMALL-SIGNAL TRANSISTOR

SCATTERING PARAMETERS

ELECTRONIC INDUSTRIES ASSOCIATION
STANDARD RS-435

Formulated by
JEDEC Solid State Products Council

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PREFACE

The symbols and terms of this document are contained in JEDEC Publication No. 77 and are not in conflict with those in IEC Publication 147-OC. The measurement procedures are similar to those published in IEC.

STANDARD FOR THE MEASUREMENT OF SMALL-SIGNAL TRANSISTOR SCATTERING PARAMETERS

(From JEDEC Tentative Standard No. 10 and Standards Proposal No. 1178, formulated by JEDEC Committee JC-24 on High Frequency Signal Diodes and Transistors and approved by the JEDEC Solid State Products Council.)

1. DEFINITIONS

1.1 Definition of the Scattering Parameters

Given a two-port network as shown in Figure 1, the scattering parameters may be defined as the elements of the matrix (1 and 2)[Ⓢ]

$$S = \begin{vmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{vmatrix} \quad (1)$$

associated with the linear equations

$$b_1 = s_{11} a_1 + s_{12} a_2 \quad (2)$$

$$b_2 = s_{21} a_1 + s_{22} a_2 \quad (3)$$

where

$$a_i = \frac{1}{2\sqrt{Z_0}} (V_i + Z_0 I_i) \quad (4)$$

$$b_i = \frac{1}{2\sqrt{Z_0}} (V_i - Z_0 I_i) \quad (5)$$

$$i = 1, 2$$

Here Z_0 is defined as a real impedance called the normalizing (or reference) impedance, usually taken to be 50 ohms. When other values are used, the value must be specified along with other conditions such as frequency, bias, temperature, etc.

[Ⓢ]Bracketed numbers refer to references on page

Each of the scattering parameters may be individually defined as follows:

s_{11} is the voltage (or current) reflection coefficient (with respect to Z_0) at port one with port two terminated in Z_0 ; i.e.,

$$s_{11} = \left. \frac{b_1}{a_1} \right|_{a_2=0} = \left. \frac{(V_1/I_1) - Z_0}{(V_1/I_1) + Z_0} \right|_{Z_1=Z_2=Z_0} \quad (6)$$

s_{12} is the reverse transmission coefficient with port one terminated in Z_0 and port two driven with a generator of impedance Z_0 ; i.e.,

$$s_{12} = \left. \frac{b_1}{a_2} \right|_{a_1=0} = \left. \frac{V_1}{(V_o/2)} \right|_{Z_1=Z_2=Z_0} \quad (7)$$

where V_o is the open-circuit generator voltage.

s_{21} is the forward transmission coefficient with port two terminated in Z_0 and port one driven with a generator of impedance Z_0 ; i.e.,

$$s_{21} = \left. \frac{b_2}{a_1} \right|_{a_2=0} = \left. \frac{V_2}{(V_o/2)} \right|_{Z_1=Z_2=Z_0} \quad (8)$$

s_{22} is the reflection coefficient (with respect to Z_0) at port two with port one terminated in Z_0 ; i.e.,

$$s_{22} = \left. \frac{b_2}{a_2} \right|_{a_1=0} = \left. \frac{(V_2/I_2) - Z_0}{(V_2/I_2) + Z_0} \right|_{Z_1=Z_2=Z_0} \quad (9)$$

The scattering parameters of transistors are also represented by the following symbols:

$$\begin{array}{lcl} s_{11} & \longrightarrow & s_{ix} \\ s_{12} & \longrightarrow & s_{rx} \\ s_{21} & \longrightarrow & s_{fx} \\ s_{22} & \longrightarrow & s_{ox} \end{array}$$

where x is replaced by e, b, or c for bipolar transistors in common-emitter, common-base, or common-collector configuration, respectively; and by s, g, or d for field-effect transistors in common-source, common-