

1974

Release of a commercial audio amplifier employing a static induction transistor (SIT) (Yamaha Corporation)

~ Discrete Semiconductor/Others ~

Static Induction Transistor (SIT) is a field effect transistor (FET) invented by Nishizawa of Tohoku University in 1950. SIT is a transistor in which the channel length of the FET is shortened and the concentration is made lower so that the drain current can be controlled by the potential profile at the boundary between the source and the channel. Quantitatively, it is important that the product of channel resistance R_s and true transconductance G_m is smaller than 1. Since this potential is influenced not only by the gate voltage but also by the drain voltage, the drain current of the SIT exhibits triode characteristic which increases without saturation as the drain voltage increases.

Mochida et al. of Yamaha developed n-channel and p-channel SITs as shown in Fig.1. An example of the drain current - drain voltage characteristic is shown in Fig.2. Yamaha commercialized an audio amplifier (B-1) using this SIT. This amplifier was strongly supported by

audio mania, and in February 2008, a reprint version (B-1a) was released from Digital Domain (<http://www.digital-do-main.com>).

SIT has developed as a power device such as high-speed operation SI thyristor after that.

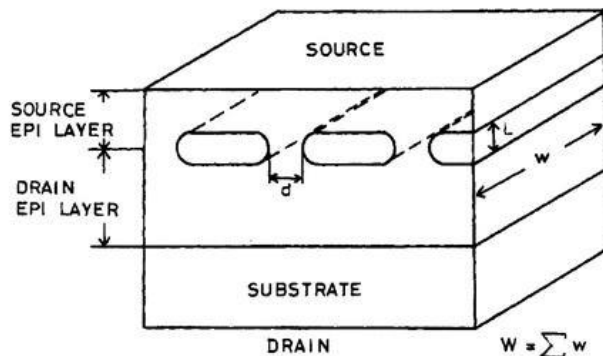


Fig. 2. Schematic structure of buried-gate SIT.

TABLE I
DEVICE PARAMETERS OF BURIED-GATE SIT

Item	2SK76 n channel	2SJ26 p channel	2SK78 n channel	2SJ24 p channel	unit
chip size	5.0	4.5	1.8	1.8	mm \square
drain epi layer thickness	33	27	45	32	μ m
impurity concn.	$3 \cdot 10^{14}$	$3 \cdot 10^{14}$	$1.5 \cdot 10^{14}$	$1.5 \cdot 10^{14}$	cm^{-3}
source epi layer thickness	14	7	10	7	μ m
impurity concn.	$2 \cdot 10^{15}$	$2 \cdot 10^{15}$	$1 \cdot 10^{15}$	$2 \cdot 10^{15}$	cm^{-3}
impurity concn. of gate mesh core	$2 \cdot 10^{19}$	$5 \cdot 10^{18}$	$2 \cdot 10^{19}$	$5 \cdot 10^{18}$	cm^{-3}
gate spacing : d	5.0	4 - 4.5	6.0	3.0	μ m
channel length : L	8.5	3.5 - 4.0	9.0	5.0	μ m
channel width : W	7.4	110	5.6	9.9	cm
ratio : W/L	$8.7 \cdot 10^4$	$27.5 - 31.4 \cdot 10^4$	$0.62 \cdot 10^4$	$1.98 \cdot 10^4$	

Fig.1: Outline of structure and key specifications of SIT developed by Yamaha [2]

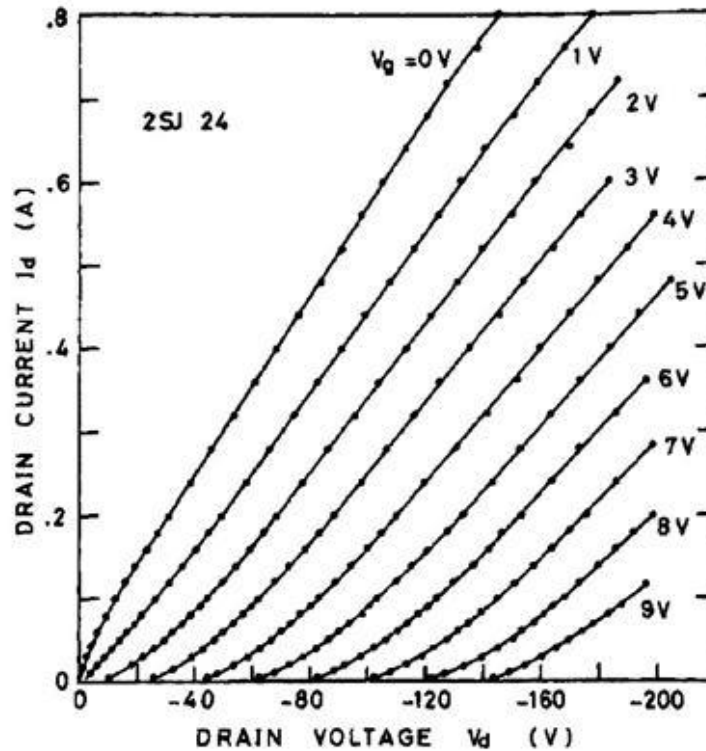


Fig. 4. Drain current versus drain voltage for 2SJ 24 (p-channel SIT): linear plot.

Figure 2: Typical drain voltage vs. drain current characteristics of SIT [2]

References:

- (1) J. Nishizawa, T. Terasaki, & J. Shibata, "Field-effect transistor versus analog transistor (Static Induction Transistor), IEEE Trans. on Electron Devices, Vol. ED-22, No. 4, pp. 185-197, (April 1975)
- (2) Y. Mochida, J. Nishizasa, T. Ohmi, & R. K. Gupta, "Characteristics of Static Induction Transistors: Effects of series resistance", IEEE Trans. on Electron Devices, Vol. ED-25, No.7, pp. 761-767, (July 1978)
- (3) T. Ohmi, "Power Static Induction Transistor Technology", IEEE IEDM Digest of Tech. Papers, pp. 84-87, (Dec. 1979)