SUMITOMO ELECTRIC INDUSTRIES, LTD.

01.03.22

♦ INTRODUCTION

This Wireless Device Data Book contains the latest information on the entire range of all GaAs IC lineups for use in wireless application especially such as mobile or wireless communication system and foundry services at SEI. These pages offer a complete description of product data including the features, applications, electrical characteristics, circuit configurations, general information, and package information. The fabrication process technology, overview of the entire lineup, outline of foundry services, and reliability assurance are also presented herein.

Beginning 100 years ago as a manufacturer of electric wires, SEI has grown to become one of the world leaders in a variety of high-technology fields since its founding in 1897. The accumulation of years of technological expertise, in conjunction with a progressive research and development policy, forms the foundation of SEI's development progress in optoelectronics, new materials and electronically-based systems. Today, SEI is a complete compound semiconductor manufacturer, performing its own process developmental design, wafer fabrication, assembly, and text. Under its historical background, SEI established a manufacturable fabrication process technology for GaAs IC's and has developed a sophisticated GaAs IC family for use in optical communications systems; the rich lineups have been introduced in the worldwide marketplace since 1986. Furthermore, new device technology for high-performance wireless application was developed recently and SEI started to deliver GaAs products for use in mobile communication systems in 1995.

SEI reserves the right to change any products herein without further notice. SEI makes no warranty and guarantee regarding the suitability of any products for use for any particular purpose. Descriptions of "typical", "minimum", and "maximum" parameters can vary from application to application and are reliable to the measurement equipment and the technical experts. Information on SEI's products described in this book is available and an additional data book specifically on SEI' Fiber Optics products and foundry service are also available for all customers.

• *SEI's FEATURES*

What is Strength?

SEI has made great advances in the successful development and manufacture of GaAs devices for use in optical communications systems. SEI was the first in the world to successfully mass-produce high-quality, large-diameter GaAs ingots, and is a leading manufacturer of compound semiconductor materials. This accomplishment contributed greatly to the commercialization of GaAs IC's worldwide. SEI's device technology has been developed through the integration of skill and its experienced historical background in the material technologies. The GaAs device technologies have taken reasonable feedback to our material technologies; SEI has promoted a mutual growth of the device and material technologies grown mutually under an excellent R&D cycle.

SEI is also a leading company of fiber optic data links. With the expansion of the demand for optical communications systems, SEI has been actively working with short-, medium-, and long-distance high-volume fiber optic transmission systems. SEI's R&D on GaAs devices for fiber transmission started in order to compete in the market place of fiber optic data links to begin with; the device and circuit technologies have been growing as strategic key devices in the great demand for discrimination of data link products. Thus another strength of ours lies in the existence internal users. The strict requirements by the internal users cultivate SEI's low-cost manufacturing technology and system-oriented circuit technique, while SEI continues to invent various integrated circuits with the highest performance, outstanding features, and user-friendly design concepts.

Studies at SEI have also driven the development of optoelectronic devices such as light emitting diodes (LED), PIN photo diodes (PD), and laser diodes (LD). These photonic devices also have contributed to technologically discriminate SEI's data link products, making SEI a leading manufacturer of optoelectronic devices as well. Needless to say, most GaAs IC's for optical communications show the best performance with the combination of the photonic devices. This optoelectronics device technology allows the fabrication technologies of the various compound semiconductor devices to mature at the low cost mass production.

Pulse-doped MESFET Technology

On the other hand, SEI possesses several strong points in wireless technology. SEI is basically a leading company of cables. With the growing demand for optical communications systems, SEI has been actively working on optical fiber cables. Thus SEI is traditionally a company which has manufactured and serviced the infrastructure of transmission systems. In the field of radio wave communications as well as optical communications, SEI has made consistent infrastructural contributions with various antennas and related products, booster equipments and base station systems for use in mobile communications systems.

SEI's R&D on GaAs wireless devices started in order to compete in the marketplace of the antenna related products and the base station systems to begin with; the device and circuit technologies have been growing as strategic key devices in the great demand for discrimination of the base station products. Another advantage of SEI's is that it has similar internal users as in the optical communications area. Furthermore, the outstanding device technology, "Pulse-doped GaAs MESFET" based on an epitaxial technology as a new transistor structure, was originally motivated and invented by the strict requirements of the internal users. Since 1988 SEI has presented many papers regarding the electron transport property, the excellent wireless characteristics, the fabrication process technology, and the related MMIC capability at international conferences. The Pulse-doped GaAs MESFET technologies have achieved excellent low noise characteristics almost equal to that of AlGaAs/GaAs high electron mobility transistors (HEMT) with the same dimension.

One of the biggest features of the pulse-doped technology is the design flexibility of the device structure, that is the thickness and doping concentration of the pulse-doped layers. This kind of design modification in the device structure can be easily conducted by the control program change of the epitaxial growing systems. Furthermore, the growth has excellent repeatability and uniformity owing to the simple epitaxial structure with only GaAs material, while HEMT's include hetero structures similar to AlGaAs materials. The most remarkable result from the design flexibility is the "Advanced Pulse-doped Structure" with dual pulse-doped layers, which was invented to improve the linearity for power application. The patent of this technology has been concluded in the U.S. and Europe as well as Japan. Recently we have developed hetero GaAs MESFET with an asymmetrical Lightly Doped Drain (LDD) structure to improve the IM3 for base station applications of digital wireless systems. The IM3 at the high and low back-off region was improved simultaneously by optimizing an LDD region. The key points to improve the IM3 are suppressing the impact ionization phenomenon, increasing the gatedrain breakdown voltage and decreasing the on-resistance. Details are described in the chapter on "WIRELESS DEVICE TECHNOLOGY". The GaAs products based on the advanced pulse-doped technology were launched as power amplifiers for internal use in the personal handy-phone system (PHS) base stations in 1995. To supply the internal demand, SEI's low-cost manufacturing technology and system oriented circuit technique have been developed.

Studies at SEI have also prompted the development of radio wave systems such as a traffic control system, a wireless LAN, and a GPS and so on. These activities also have substantially contributed to technologically discriminate SEI's wireless products, securing SEI a leading spot as a manufacturer of wireless components and systems.

SEI's remarkable strength thus lies in its ability to integrate and maximize all the indispensable technologies.

What is SEI's Feature?

SEI's fabrication process is called a Single-layer Resist Dummy-gate self-aligned (SRD) process based on the conventional photolithography and completely ion-milling metal processes, featuring high uniformity and excellent reproducibility. Quick delivery, typically eight weeks from mask-out, allows customers to shorten their lead time to develop. Customers can choose their preferred process menu from two categories; an ion-implantation process or epitaxial based process. SEI provides four menus from the ion-implantation process and two menus from the epi-based process.

Why GaAs?

The existing market for SEI's devices is high-speed silicon bipolar users, and occasionally high-performance CMOS or NMOS users. The most notable feature in a GaAs field effect transistor (FET) is lower noise characteristics than a silicon bipolar junction transistor (BJT). GaAs devices are used for one simple reason - speed. In terms of high-speed performance, BJT circuits can accurately satisfy the given specification up to at least a couple of hundred Mbps. The equivalent input noise current density (I_{Nin}) in a GaAs IC, however, far out-powers that of a silicon IC; for instance, in the case of a transimpedance preamplifier for a 125 Mbps FDDI LAN, the GaAs IC achieves 1.17 pA/√Hz of I_{Nin} while that of the silicon IC shows over 8 pA/√Hz. The low-noise feature in GaAs IC's contributes to improve the receiver sensitivity which is the defining parameter for a receiver circuit. Furthermore, this effect is more remarkable with higher speed.

On the other hand, in the case of a transmitter circuit, an LD or LED driver circuit, for example, the output optical wave shape is extremely important. Many customers have strong requirements of ringing-free, low duty-cycle-distortion (DCD), small jitter, and fast rise-time (tr) and fall-time (tf). The transmitter circuit, up to a couple of hundred Mbps, may achieve the specification on the wave shape regulated in the international specifications. However, a superior wave shape can be obtained if a GaAs IC is applied, because the high-speed swing characteristics in the internal circuit and low-noise features are very effective for low DCD or small jitter. While the abruptly overshooting drive currents should be applied to the LD or LED to achieve fast tr and tf performance, such overshooting currents cause an undesirable ringing. The GaAs MESFET structure itself is considered suitable for suppression of the ringing compared with that of the silicon BJT, that is, the intrinsic high-speed performance and the parasitic series resistances allow effective suppression of the ringing.

In further higher-speed ranges, the intrinsically high resistivity of GaAs substrates strongly contributes to the design flexibility and results in high performance. All the patterns formed on a GaAs or a silicon substrate have undesirable parasitic capacitance which greatly affects high-frequency operation. The silicon IC has a disadvantage from the standpoint of the effect of parasitic capacitance owing to the substrate conductivity.

The market for SEI's wireless devices is the existing silicon bipolar and silicon NMOS users. The most notable feature in a GaAs FET is lower noise characteristics than silicon transistors. GaAs devices are used for their high cutoff frequency. In terms of high-frequency performance, silicon circuits can accurately satisfy given specification up to at least a couple of hundred MHz. The low-noise feature in GaAs IC's contributes to improve the receiver sensitivity which is the defining parameter for a receiver circuit. Furthermore, this effect is more remarkable for higher frequency over 1 GHz.

On the other hand, in the case of a transmitter circuit, the distortion characteristics are extremely important especially in mobile and wireless applications. As the silicon BJT has an exponential characteristic for the relation between the base current and corrector current, it is basically less advantageous than GaAs FET's.

In further higher-frequency ranges, the intrinsically high resistivity of GaAs substrates contributes considerably to the design flexibility and results in high performance. All the patterns formed on a GaAs or a silicon substrate have undesirable parasitic capacitance which deeply affects high-frequency operation. The silicon IC has a disadvantage from the standpoint of the effect of parasitic capacitance owing to the substrate conductivity.

What is New?

A single resist-layer dummy-gate (SRD) process was originally developed for GaAs IC’s, featuring excellent manufacturability of reproducibility and uniformity to realize low cost and high volume production, adequate electrical characteristics of a transconductance (gm), current cutoff frequency (f_T), and drain breakdown voltage (Vb), which are critical for the design of analogue circuits such as transimpedance amplifiers or LD/LED drivers.

Particularly for applications of low-noise circuits and power amplifiers, SEI can provide the "Pulse-doped GaAs MESFET" based on an epitaxial technology. Compared with a conventional ion-implanted MESFET or an HEMT, this special device features higher linearity and lower power consumption. SEI has invented various unique MIC modules with "Pulse-doped GaAs MESFET" technology, and supplies to many customers.

What is Strategic Emphasis?

SEI’s strategy is focused on enhancing its visibility as a leading developer of optoelectronics, new materials and systems. Illustrating its commitment to these high-growth-potential areas, the company has consistently supported its strategy with major outlays of financial and human resources.

While SEI has made great efforts to develop and produce GaAs IC’s, a comprehensive product development with an all-round policy has been virtually untouched. SEI has been focusing on the GaAs IC development in the limited field of optical communications and mobile/wireless communications with, special emphasis on product, which share features difficult for silicon IC's to achieve, and which can technologically discriminate products by other GaAs IC vendor, and primarily contribute an construct the economical communications infrastructure with higher added value.

SEI's GaAs IC technology has paved the way to achieve the highest speed fiber transmission systems and the most sophisticated wireless communication systems, meeting the demands of the age. SEI will be increasingly technology-oriented, in terms of constantly enhancing our ability to develop the most advanced technologies. At the same time, SEI will be at the leading edge of changes in industry, technology and society and be a market-oriented, customer-driven company.

• *DATA SHEET DESIGNATIONS*

ADVANCE

Advance data sheets provide specifications for products not yet completed yet or fully characterized. The advance data sheets present suggested specifications; therefore, a part of parameters may be rewritten afterwards. They do, however, provide adequate design target information for customer-planning purposes. The word "ADVANCE" is necessarily marked on the first page of each product data sheet.

PRELIMINARY

Preliminary data sheets describe specifications for products which have satisfied the full characterization of a few samples only at room temperature. It is possible to rewrite them afterwards as well, because slight differences will occur by large volume estimation and so on. The word "PRELIMINARY" is necessarily indicated on the first page of each product data sheet.

FINAL

Final data sheets provide fully characterized information on the products by sufficient volume estimation including the temperature characteristic measurement. No special marking appears on data sheets.