New Bi-HEMT Technology with Low On-Resistance pHEMT for LTE Application
Bing-Shan Hong, Shu-Hsiao Tsai, Cheng-Kuo Lin, Shinichiro Takatani, and Dennis Williams
WIN Semiconductors Corp. Kuei Shan Hsiang, Tao Yuan Shien, 333, R.O.C.
E-mail: andytsai@winfoundry.com, Phone: +886-3-3975999#1512

Abstract
Monolithic Integration of pHEMT and InGaP HBT Technology on 150-mm GaAs Wafers has been widely used in 3G and WiMax applications. BiHEMT technology (H2W is the code name at WIN) provides useful degrees of freedom for the design of power amplifiers. HBT is used for the power cell to provide sufficient power output and linearity where required. pHEMT is used for bias-circuits and power switching to achieve high efficiency at low power mode.

Presently WIN semiconductors offers two versions of H2W technologies with variation in HBT current gain to address customer requirements. The pHEMT device performance is targeted for bias circuit design. Next generation device architectures that will support integrated solutions adding 4G LTE to the MMMB module require a pHEMT with reduced on-resistance to enable the design of in-line power switched devices. In order to improve the on-resistance, WIN Semiconductors has developed a new H2W technology with a single gate recess process and optimized pHEMT epi-structure design to improve rf switch performance in the H2W process offering and bring it in line with best available for stand-alone pHEMT switch technologies (Fig. 1).

The threshold voltage (\(I_{dss}=1\)mA/mm) and drain-to-source current density (\(I_{dss}\)) of the pHEMT are -1 V and 335 mA/mm, respectively (Fig.2a). The on-resistance of the pHEMT is 0.9 ohm.mm, achieving a 50% on-resistance reduction compared with previous H2W versions (Fig. 2b). Gate leakage current and breakdown voltage of the pHEMT are maintained at their previous low level for normal rf switch operation (Fig 3). We evaluated the rf switch performance by using a single gate 9x125-µm device with series topology. The insertion losses are 0.1 and 0.15 dB for the new and original H2W processes respectively. Regarding switch linearity, 80 dBC of second-harmonic power and third-harmonic power were obtained with the device biased at -3V.

For the HBT, the typical turn-on voltage of the is 1.26V. The base layer is designed with dc current gain of 125. BC and EC breakdown voltages are 28V and 17V, respectively. (Table 1)

In summary, WIN Semiconductor’s new H2W technology provides world class pHEMT performance combined with rugged and proven HBT technology for the design of next generation power amplifiers for LTE high linearity application.
Fig 1. SEM photograph of triple gate devices for rf-switch application

Fig 2(a). The transfer curves of 0.5-µm pHEMTs of H2W

Fig 2(b). The DC-IV characteristic comparison of H2W pHEMT devices

Fig 3. Revised Schottky gate leakage characteristic of H2W.

Table 1. DC and RF performance summary of H2W