IDEC Chip Design Contest

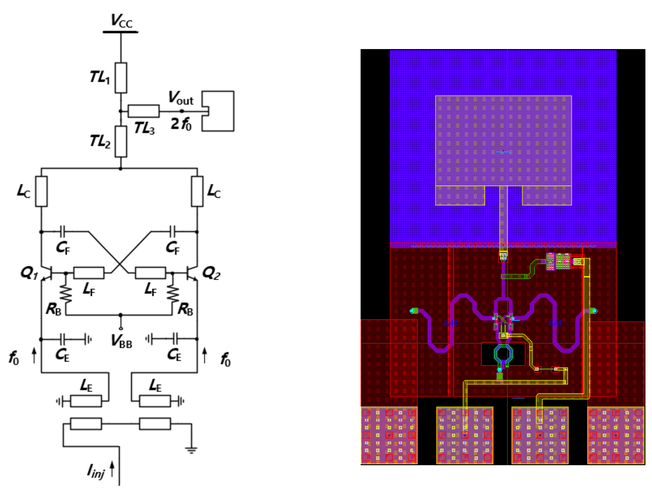
A 637-GHz Injection-Locked Oscillator based on InP HBT Technology

G. Nam, W. Keum, J. Lee, J. Jang, M. Choi, M. Kim and J.-S. Rieh
High Speed Integrated System Lab.
Korea University, Anam-ro 145 Seongbuk-gu, Seoul, Korea

Introduction

The sub-mmwave band beyond 300 GHz can be utilized for various fields such as communication, imaging and radar systems. For the implementation of high-frequency systems, a high-performance, such as high power and low phase noise, signal source is an essential component. In this work, a 600-GHz injection-locked oscillator (ILO) is designed as a part of signal source based on 250-nm InP HBT technology.

1. Circuit Design



(a) (b)

Fig. 1 Injection-locked oscillator (a) schematic (b) layout

- Fig. 1 shows the schematic and the layout of injection-locked oscillator (ILO).
- The LC cross-coupled push-push structure is adopted to the oscillator design for fundamental signal suppression and extracting second harmonic signal.
- The capacitor and the shunt transmission line are added to the emitter stage to achieve lower the negative resistance of the oscillator core [1].
- At the emitter stage, the shunt transmission line is composed of transformer based balun which converts the single-ended input signal into a differential signal.
- The patch antenna matched at 2^{nd} harmonic frequency is integrated at the output stage of the oscillator for 2^{nd} harmonic radiation and fundamental signal suppression.
- The transmission line TL1 is employed as a DC feed line and also as fundamental suppression.
- The layout of the circuit is shown in Fig. 1 (b).

2. Simulation Result

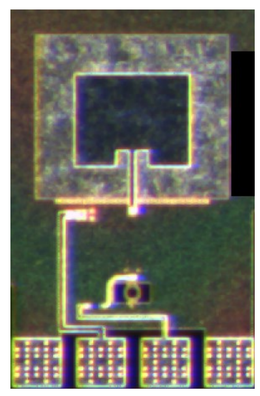
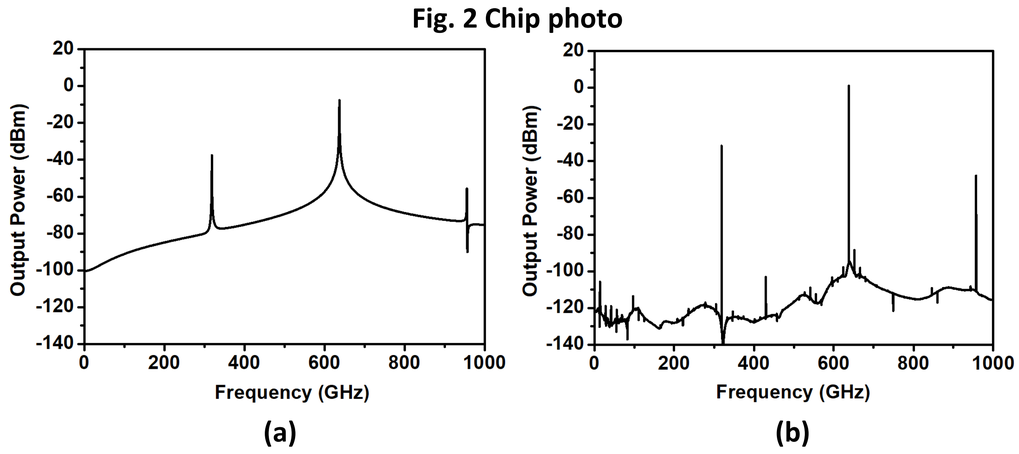


Fig. 2 Chip photo



(a) (b)

Fig. 3 Simulated results of injection-locked oscillator

- Fig.2 shows the chip photo of fabricated ILO.
- The size of chip with DC pads is 374 × 548 μm^2.
- The output power against frequency is shown in Fig.3.
- Fig. 3 (a) shows simulated result of free-running oscillation. The peak output power is -7.6 dBm at 637.3 GHz.
- The injection locked simulation result is shown in Fig. 3 (b), the peak output power is 1 dBm at 640 GHz with 0 dBm at 320 GHz injected signal.
- The DC power consumption is 20.7 mW.
- The asymmetry of the oscillator core induced a reduction in output power, the measured second harmonic signal decreased by 20 dB.

Conclusion

In this work, 600-GHz ILO is fabricated based on 250-nm InP HBT technology. It has -7.6 dBm peak output power at 637.3 GHz with free-running condition. With 0 dBm injection signal at 320 GHz, the peak output power is 1 dBm at 640 GHz. This circuit will be measured with spectrum analyzer and power meter to evaluate output frequency and output power. The designed ILO can be applied to wireless communication systems, imaging systems or radar systems.

Acknowledgement

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Reference

[1] H. Son, J. Kim, K. Song, D. Kim, J. Yoo and J. -S. Rieh, "600-GHz High-Power Signal Sources Based on 250-nm InP HBT Technology," in *IEEE Transactions on Terahertz Science and Technology*, vol. 12, no. 6, pp. 648-657, Nov. 2022.

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