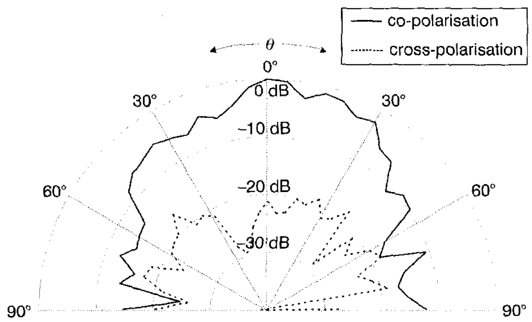

Fig. 3 *Cross-polarisation*

Conclusion: We have presented a spherical array self-mixing oscillator antenna. The beam steering antenna with considerably constant pattern can be realised without using the sophisticated phase shifters by using the injection locking technique. The application of interest is a steerable feed for a reflector antenna.

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References

1 QIAN, Y., and ITOH, T.: 'Progress in active integrated antennas and their applications', *IEEE Trans. Microw. Theory Tech.*, 1998, **46**, pp. 1891–1900
2 MONTIEL, C.M., FAN, L., and CHANG, K.: 'A novel active with self-mixing and wideband varactor-tuning capabilities for communication and vehicle identification applications', *IEEE Trans. Microw. Theory Tech.*, 1996, **44**, pp. 2421–2430
3 MONTIEL, C.M., FAN, L., and CHANG, K.: 'An X-band self-mixing oscillator antenna for transceiver and spatial power-combining applications', *IEEE Trans. Microw. Theory Tech.*, 1998, **46**, pp. 1546–1551
4 SENGUPTA, D.L., SMITH, T.M., and LARSON, R.W.: 'Radiation characteristics of a spherical array of circularly polarized elements', *IEEE Trans. Antennas Propag.*, 1968, **16**, pp. 2–7

Ultra-wideband (from DC to 110 GHz) CPW to CPS transition

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A new ultra-wideband, low-loss and small-size coplanar waveguide (CPW) to coplanar strip (CPS) transition which can be used from DC to 110 GHz is presented. The proposed transition connects CPW with CPS by the reformed air-bridge. Two ground planes of CPW are tied at their ends by a line and the centre of the line is connected to the ground strip of CPS by another line. Owing to the symmetry of the proposed structure, the currents of two ground planes of CPW are combined with the same phase and transferred to the ground strip of CPS. With height of 3 μm, the signal line of CPW passes over two connecting lines and is connected to the signal strip of CPS. For the back-to-back transition structure, insertion loss < 1 dB and return loss > 15 dB are obtained from 0.5 to 110 GHz.

Introduction: Coplanar waveguide (CPW) and coplanar strip (CPS) transmission lines are typical uniplanar structures which have many attractive features for use in monolithic microwave integrated circuits (MMICs). They allow series and shunt mountings of devices in a circuit. The fabrication process is simple since there is no backside processing. Moreover, they are usually less dispersive than microstrip lines.

The transitions between CPW and CPS are often used to exploit the advantages of uniplanar structures. CPW to CPS transitions are widely used in uniplanar balanced circuits such as mixer [1], antenna [2] and various other uniplanar circuits.

Much work has been carried out on the development of broadband transitions between CPW and CPS. Some has been reported with the insertion loss < 1 dB at the frequency range of 0–4.8 GHz [3], 1.6–7.0 GHz [4] and 0–50 GHz [5]. However, these approaches are band-limited, so ultra-wide applications up to W-band are not possible. Conversely, the proposed transition can be used up to 110 GHz.

Circuit configuration: To realise broadband transitions, some researchers have adopted radial stubs [4] or hollow circular patches [3]: however, these structures are band-limited owing to the frequency dependency of the radial stub and the hollow circular patch. A different approach using a simple air-bridge structure was proposed for the very wideband CPW to CPS transition [5]: however, although the structure achieved the bandwidth over 50 GHz, it cannot be used up to W-band.

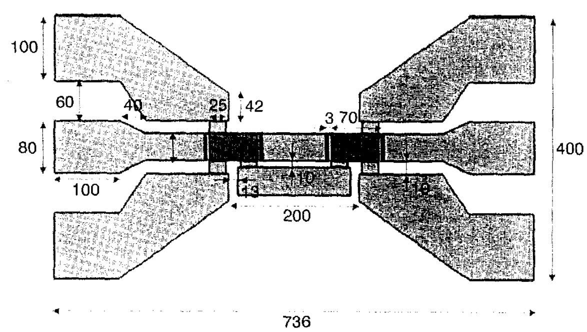

Fig. 1 *Top view of back-to-back configuration of proposed CPW to CPS transition (dimensions in μm)*

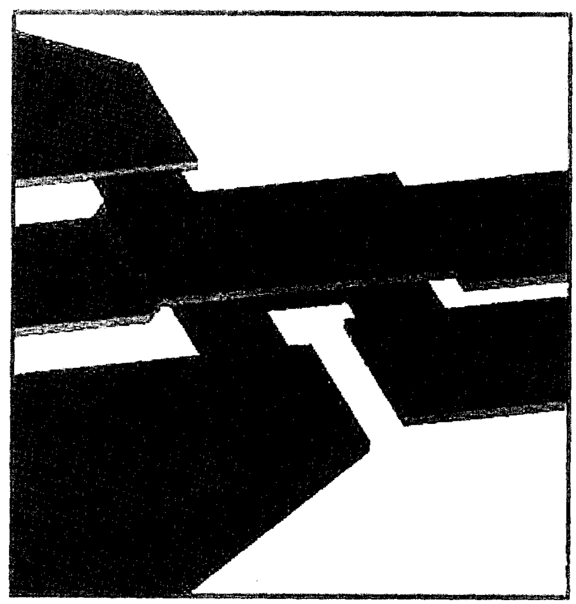

Fig. 2 *Side view of proposed CPW to CPS transition*

By reforming the air-bridge structure which connects CPW to CPS, we present a low-loss and ultra-wideband CPW to CPS transition which can be used up to 110 GHz. Fig. 1 shows the top view of the back-to-back configuration of the proposed transition with its dimensions. The side view of the transition is presented in Fig. 2. The semi-insulating GaAs substrate is 650 μm thick and the dielectric constant is 12.9. The thickness of the second metal is 2 μm, the thickness of the first metal 0.5 μm. The second metal is used for the signal lines and ground planes of CPW and CPS. The first metal is used for the line connecting two ground planes of CPW. It is also used for the line connecting the ground strip of CPS with the line which connects two ground planes of CPW.

As shown in Figs. 1 and 2, the proposed transition connects CPW with CPS by the reformed air-bridge structure. The two ground planes of CPW are connected at their ends by a short first metal line the centre of which is connected to the ground strip of CPS by another first metal line. Compared with the structure proposed in [5], this transition makes the currents flowing on two ground planes of CPW be combined with the same phase and transferred to the ground strip of CPS. We believe that this symmetric combining structure improves the high frequency characteristics of the proposed transition up to 110 GHz. With height of 3 μm, the signal line of CPW passes over the first metal lines connecting CPW with CPS and is connected to the signal strip of CPS.

Experimental results: A back-to-back transition circuit was fabricated on a 650 μm semi-insulating GaAs substrate. The insertion loss and return loss of the back-to-back transition were simulated and measured from 0.5 to 110 GHz. The results are shown in Figs. 3 and 4, respectively. The simulation was performed by Microwave Studio V3.0, and the on-wafer measurement was done using an HP8510XF network analyser. The two results agree reasonably well. From Figs. 3 and 4, it is found that an ultra-wideband CPW to CPS transition can be obtained by the proposed structure, which has insertion loss <1 dB and return loss >15 dB from 0.5 to 110 GHz.

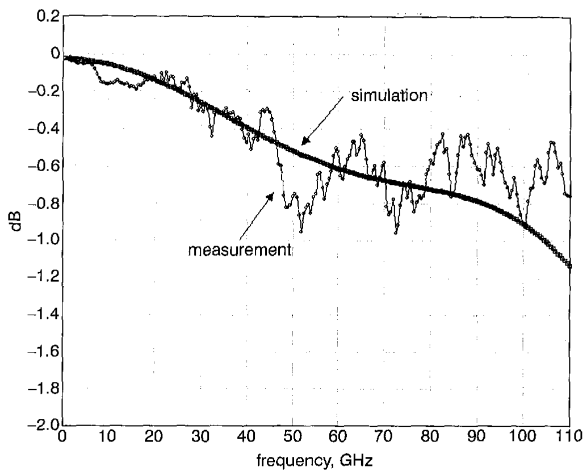

Fig. 3 *Simulated and measured insertion loss for CPW to CPS back-to-back transition*

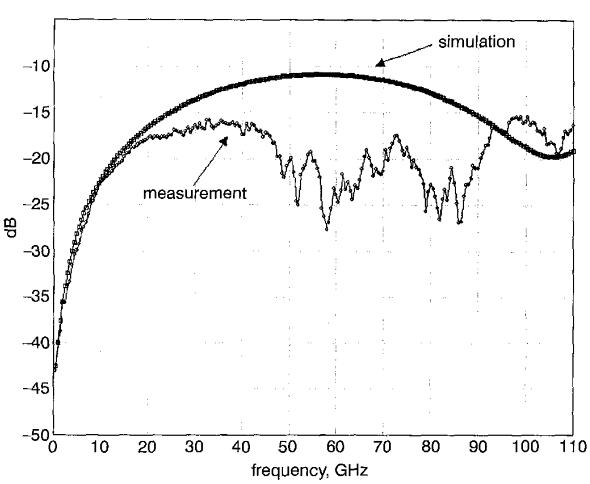

Fig. 4 *Simulated and measured return loss for CPW to CPS back-to-back transition*

Conclusion: An ultra-wideband, low-loss and small-size CPW to CPS transition has been developed. It uses a reformed air-bridge structure to achieve an in-phase current combining in the transition. The proposed transition has insertion loss <1 dB and return loss >15 dB from 0.5 to 110 GHz for back-to-back transition. This simple, small-size, low-loss and ultra-wideband CPW to CPS transition can be applied to various uniplanar MMIC circuits at very high frequency.

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References

1 CHIOU, H.K., CHANG, C.Y., and LIN, H.H.: 'Balun design for uniplanar broadband double balanced mixer', *Electron. Lett.*, 1995, **31**, pp. 2113–2114

2 SIMONS, R.N., PONCHAK, G.E., LEE, R.Q., and FERNANDAZ, N.S.: 'Coplanar waveguide fed phased array antenna'. IEEE Antennas Propagation Int. Symp. Dig., 1990, Vol. 4, pp. 1778–1781

3 TILLEY, K., WU, X.D., and CHANG, K.: 'Wideband transition from conductor-backed coplanar waveguide to modified coplanar stripline using multiple substrates', *Electron. Lett.*, 1993, **29**, pp. 2051–2052

4 HO, C.H., FAN, L., and CHANG, K.: 'Broad-band uniplanar hybrid-ring and branch-line couplers', *IEEE Trans. Microw. Theory Tech.*, 1993, **41**, pp. 2116–2125

5 PRIETO, D., CAYROU, J.C., CAZAUX, J.L., PARRA, T., and GRAFFEUIL, J.: 'CPS structure potentialities for MMICs: a CPS/CPW transition and a bias network'. IEEE Microwave Theory and Techniques Symp. Dig., Baltimore, MD, USA, 1998, pp. 111–114

Chaos generator via Wien-bridge oscillator

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A new chaos generator obtained by designing a controller for the celebrated Wien-bridge oscillator is presented. The chaotic attractor exhibited in this generator is globally attractive and stable in the Liapunov sense and is more practical for engineering problems.

Introduction: The design of a chaos generator has received considerable attention and many novel and simple nonlinear circuits exhibiting chaotic dynamics have been proposed [1–5]. Some well known examples are Chua's circuit (and variation and generalisations) [4]. However the Liapunov stability of the attractor, in the sense that every solution with initial condition near the chaotic attractor still remains in the vicinity of the attractor, is not guaranteed or clear for the aforementioned circuits. In this Letter we present a chaos generator obtained by designing a controller for a modified version of the celebrated Wien-bridge oscillator. The chaotic attractor exhibited in this generator is globally attractive and stable in the Liapunov sense and is more practical for engineering problems.

Circuit equation and design: By means of modifying the Wien-bridge oscillator with a controller we obtain the following circuit