Improvements can easily be made to High Performance 6GHz+ RF Prescaler

The article on the 6GHz+ RF Prescaler project (May 2017; www.siliconchip.com.au/Article/10643) contains contradictory statements. Towards the end of the section headed "Output Stage", it says the output impedance is 75Ω, the output voltage swing is 2V peak-to-peak but only about 300mV when terminated with 50Ω or 75Ω.

If the output impedance were actually 75Ω, terminating it with an equal value would exactly halve the output voltage. This much larger observed change implies a much higher output impedance.

A glance at the circuit diagram makes it obvious that the output impedances are actually 300Ω.

Q1 and Q2 form a long-tailed pair and act as a current source, presenting a very high (ideally infinite) impedance, so the output impedances are determined solely by the resistances between CON1 and CON2 and ground. It is not clear that the 100Ω resistors serve any useful purpose, their impedance is negligible in comparison to that presented by Q1 and Q2.

Closer examination reveals a further anomaly: for an ECL output-low level of nominally 1.95V, the Q1/Q2 emitter current should be approximately 8.8mA, which is switched alternately to the two 300Ω output resistors, giving output voltages of 2.7V into an open circuit, 528mV into 75Ω and 378mV into 50Ω. The observed 2V unloaded output is clearly very low.

The reason for this is that, with its base at 1.95V, Q1's emitter will be at about 2.1V and, with the given 400Ω collector load, Q1 will saturate (the same applies to Q2). When saturated, the predicted open-circuit output voltage is 2.05V, in good agreement with that observed. Transistors are slow to recover from saturation so it is best avoided in high frequency circuits. Output terminations below 220Ω will prevent saturation of Q1/Q2.

To properly match 75Ω (or 50Ω) lines, the 300Ω resistors could be replaced with 75Ω (51Ω) resistors (or perhaps one of each), giving open circuit output of 660mV (450mV), and 330mV (225mV) into matching loads. These levels could be increased by reducing the value of the 330Ω Q1/Q2 emitter resistor.

Anthony John Ellis,
Wellington, New Zealand.

Editor's note: your analysis is correct. This part of the circuit was based on a number of previous prescaler circuits, none of which were criticised as being incorrect, although they clearly were.

The assumption was obviously that the output impedance of Q1/Q2 was zero, so the 100Ω and 300Ω resistors in parallel gave an output impedance of 75Ω. But as you point out, this assumption was wrong because of the high collector source impedances of transistors Q1 & Q2.

Your suggested changes can be made by simply substituting 0Ω resistors for the 100Ω resistors and 75Ω resistors for the 300Ω resistors.