TRF1015

QUESTION: "How does the TRF1015 perform at 400 MHz relative to it's performance at 900 MHz?"

ANSWER: Although the TRF1015 was originally intended for ISM and Cellular applications, its broadband performance is usable in many systems. The IC operates at 400 MHz with some changes in performance. The noise figure and gain will increase, while the IP3 will decrease. Also, the associated circuitry on the PC board would be significantly different at this operating frequency. The IC consists of the following cells; LNA, Mixer, LO Buffers, VCO, and bias and logic circuitry.

LNA:
The LNA on the TRF1015 should work at 400 MHz but will have higher gain than at 900 MHz. The noise figure at 400 MHz should improve compared to 900 MHz, but the input referenced IP3 will be lower due to the increase in gain. Some of the increase in gain can be reduced by using fewer of the LNA ground pins. The IC has 4 LNA ground pins for use at 900 MHz. By reducing the number of ground pins that are connected on the PC board when used at 400 MHz, the LNA ground inductance will increase, the gain will be reduced, and the input IP3 will improve.

Mixer:
The mixer on the TRF1015 should also work at 400 MHz, but will also have a higher gain, lower noise figure and poorer input IP3. The mixer only has one "ground" lead. However, this lead is not actually connected directly to ground, but is connected to ground through a parallel RC circuit on the PC board. The resistor in this circuit is used to provide a DC path to ground while the capacitor is used to resonate out some lead inductance. By resonating out the lead inductance, the gain at 900 MHz is improved. For 400 MHz operation, I would recommend that the mixer ground lead be grounded directly on the board to reduce the gain.

LO Buffers:
There are 2 LO buffers on the IC. One drives the mixer, and the other drives the off-chip LO outputs. Both contain on-chip coupling capacitors which will create some limitations for low frequency operation. The buffer that drives the mixer should still be OK at 400 MHz, since the load it is driving is also capacitive and thus should be higher impedance at 400 MHz. Also, the buffer itself should have more gain at 400 MHz. The buffer that drives the LO outputs is more limited. The buffers are capacitively coupled with 3 pF on each output. Thus it will cause an increase in VSWR at 400 MHz, but the output level should be about the same due to an increase in the buffer gain.

VCO:
The VCO will work well at 400 MHz but the off-chip circuitry will have to be changed. If a similar resonator is used for the VCO tank, the phase noise should improve by about 6 dB. If a less costly LC tank is used, the phase noise will be higher, but less area will be required. Also, the IC can be used without operating the VCO if desired.

Digital Logic and Bias:
The digital logic and bias circuitry are not frequency dependent and should not be impacted by a change in the frequency plan.

Question: Is the output of the mixer open-collector? If so, can the user pull it up to something besides Vdd? If so, what would be the constraints?
Answer: Yes, the output of the TRF1015 mixer is open-collector. The user can pull the output of the mixer up to another supply that is larger than or smaller than Vcc, say Vss. The constraints would be keeping 3.5V<Vss<6.0V. The 6.0V maximum is based on the datasheet's maximum supply voltage. The 3.5V minimum is based on the recommended operation conditions. Please note that the specifications for the TRF1015 mixer are guaranteed only at Vcc = 3.75V.

Question: On pins 19 and 20 (Mix_out), what are the purposes of the external components (e.g. is it a balun, impedance matching, etc.)?
Answer: The TRF1015 applications circuits in Figures 1 and 2 of the datasheet allow simple and straight-forward testing of the TRF1015. In particular, the differential output of the Mixer is brought out to an equivalent single-ended measurement point (J19). Vcc is applied to pin 20. This transmission line also acts as an RF ground (C11 and C10 are used as by-pass caps to shunt any RF to GND). Vcc is also supplied to pin 19 by means of L4. L4 also acts as an RF choke. L4 and C12 form a tank that resonates at the IF (45 MHz):

f=1/(2*pi*SQRT(LC)) = 1/(2*pi*SQRT(220e-9*56e-12)) ~ 45 MHz.

R1 is used to lower the Q of the tank and, thus, to broaden the band width. C13 and L8 are used as an impedance matching network to match the impedance to 50 Ohms (for testing purposes). C13 and L8 also act as a simple LPF. C21 is a dc-blocking cap.

Question: The datasheet indicates the IF frequency is 45 MHz and that the measurements are made using the recommended application board; under these conditions, how can 15 dB return loss (into 50 ohms) be achieved at the mixer output with a 680 nH series inductor on the application board?
Answer: The TRF1015 mixer output matching circuitry consists of the 680 nH series inductor (L8) and the 18 pF shunt capacitor (C13). This matching circuitry provides a good impedance match to the 50 Ohm measurement environment resulting in a 15 dB return loss measurement at J19.