Application Report
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TRF3703xx Quadrature Modulators Improve Spurious Emission and Save Power in TDD Applications

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ABSTRACT

This report describes how to use TI's TRF3703xx Quadrature Modulators family in Time Division Duplex (TDD) applications. The TRF3703xx family has superior noise and linearity performance. Of most importance are:

- –163 dBm/Hz output noise density
- 26 dBm of OIP3
- 12 dBm of P1dB
- 40 dBm of carrier feedthrough rejection
- 45 dBc of sideband suppression

In addition to the aforementioned performance advantages, turning off the modulator eliminates carrier feedthrough and intermodulation distortions as well as reducing power consumption in a TDD system. Using this power savings during a receive cycle in TDD applications makes the system more efficient and cost-effective.

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1 Introduction

TDD is becoming more cost-effective because it uses a single frequency to transmit in both the upstream and downstream directions. TDD uses dynamic bandwidth (BW) allocation; this BW allocation asymmetry is useful for bursty traffic such as e-mail, internet, and other data traffic. TDD uses one antenna that divides its time between the transmitting and receiving of signals. It has been used in Europe's DECT (digital European cordless telecommunication) systems, in China's Time Division – Synchronous Code Division Multiple Access (TD-SCDMA) systems, *WiMAX*, *WiBro*, and Japan's personal handyphone systems.

An output switch toggles the antenna to the TX or RX path. In typical applications the rate at which the system toggles between TX and RX is on the order of 5 ms. When the radio is in RX mode, the TX path is dormant, and can be turned off to eliminate spurious output and to reduce power consumption. When the switch toggles back to the TX side, the TX circuitry must come back on and be stable within the guard interval.

2 Test Results

The TRF3703xx uses two separate power-supply pins. The VccLO pin powers the LO buffer circuitry. The VccMOD powers the mixer circuitry. See Figure 5 for the evaluation board schematic for reference.

The following figures show four transient responses. The first two figures, Figure 1 and Figure 2, show the transient responses when just VccLO is switched from off to on and vice versa. Figure 3 and Figure 4 show the transient response when both power supplies are toggled simultaneously. Figure 1 shows the output power as a function of time when VccLO (pin 24) is pulled up from 0 V to 5 V. Figure 2 shows the output power as a function of time when VccLO (pin 24) is pulled down from 5 V to 0 V. Both I/Q signals and the LO are present during power cycling. Figure 3 shows the output power as a function of time when both the modulator power supply, VccMOD (pin18), and the LO power supply, VccLO (pin 24), are pulled up from 0 V to 5 V. Figure 4 shows the output power as a function of time when both the modulator power supply, VccMOD (pin18), and the LO power supply, VccLO (pin 24), are pulled down from 5 V to 0 V. In both the power-down and power-up operation, there is a smooth transition with no glitches in output power. It can be seen from these four figures that the turnon and turnoff for the device are on the order of 3 µs.

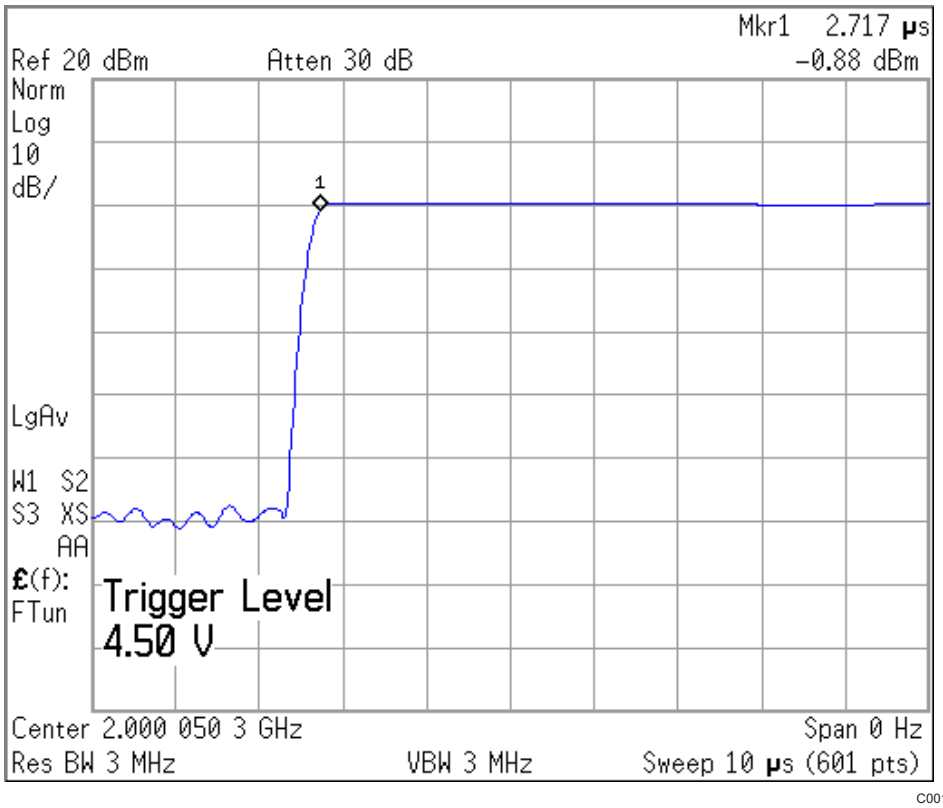

Figure 1. Output Power vs Time With VccLO Power-On Operation (From 0 V to 5 V)

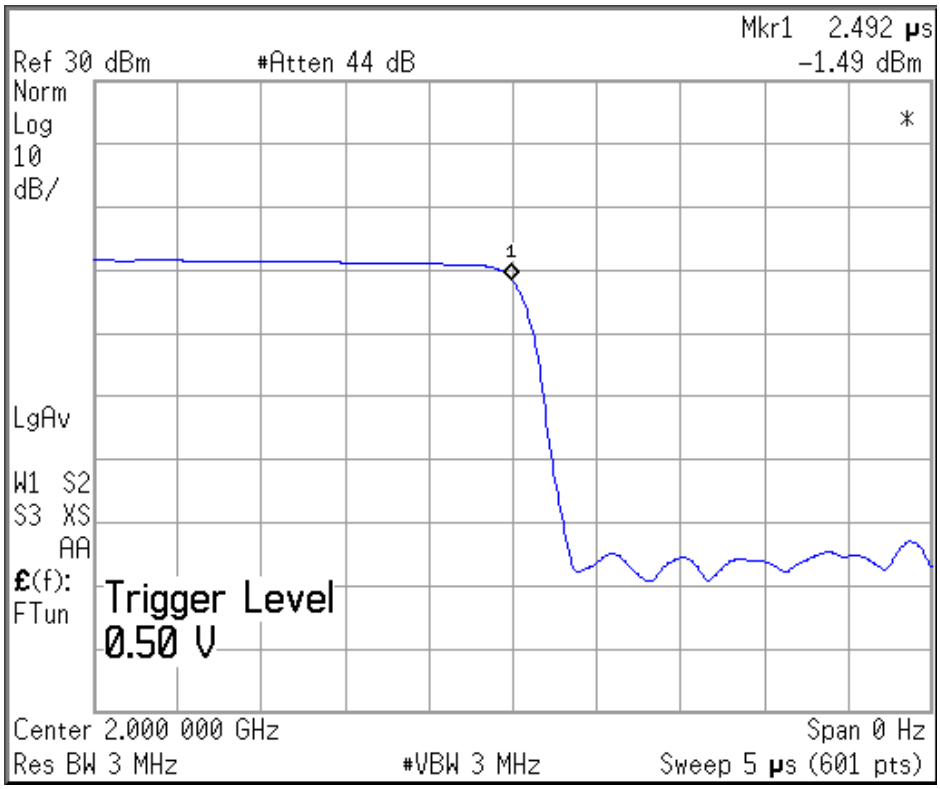

Figure 2. Output Power vs Time With VccLO Power-Off Operation (From 5 V to 0 V)

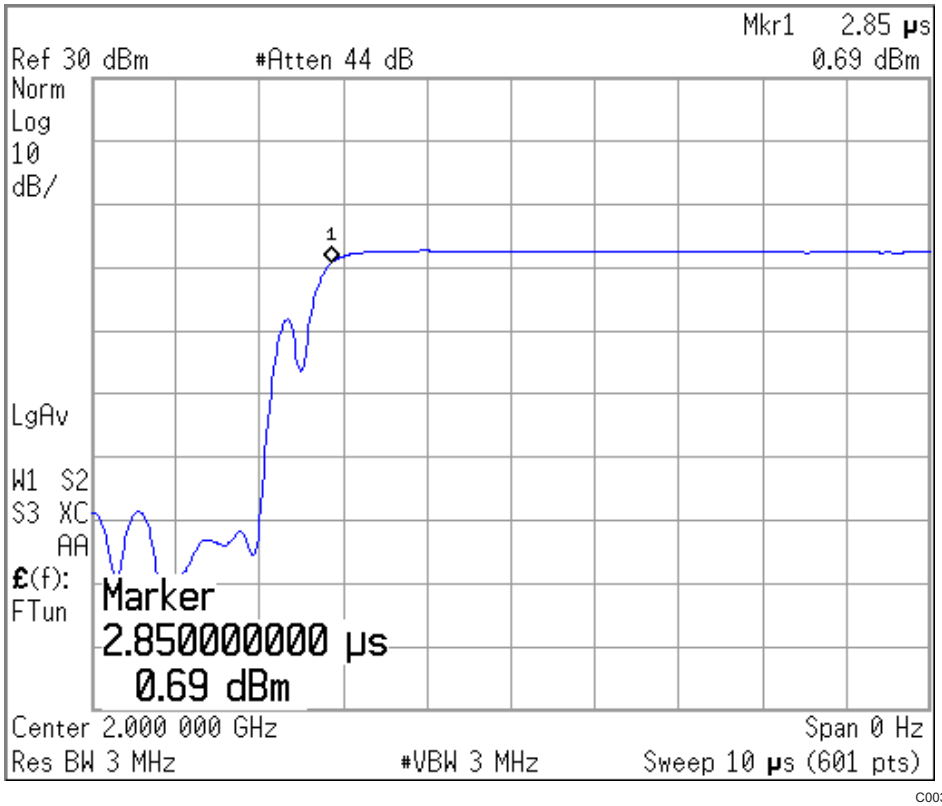

Figure 3. Output Power vs Time During Power-On Operation (0 V to 5 V)

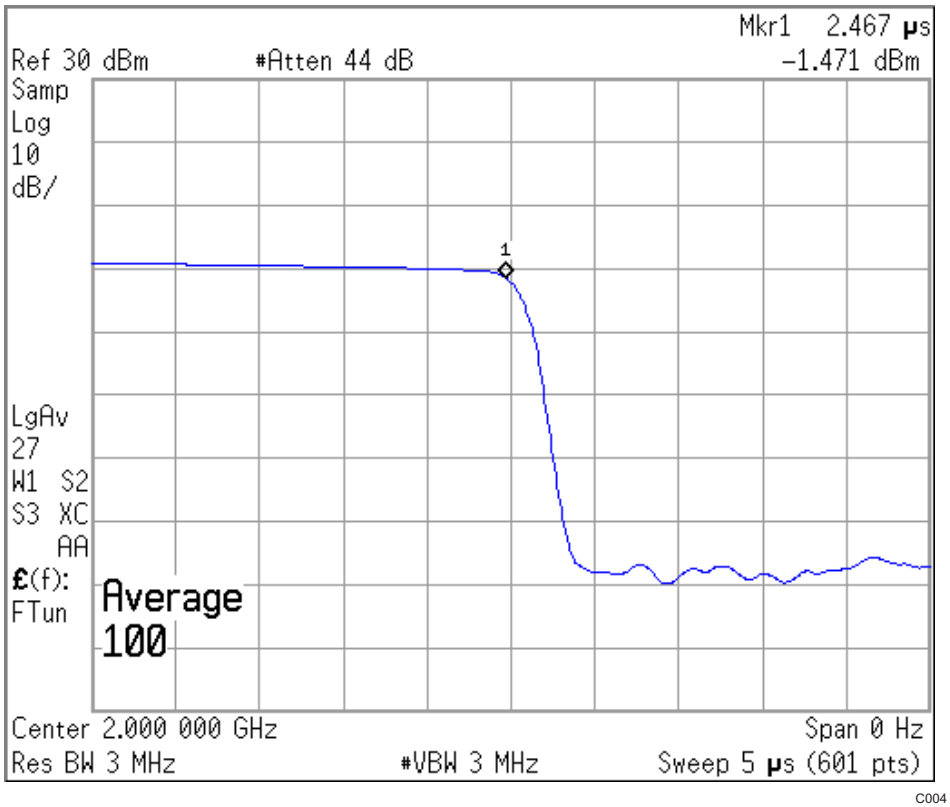

Figure 4. Output Power vs Time During Power-Off Operation (5 V to 0 V)

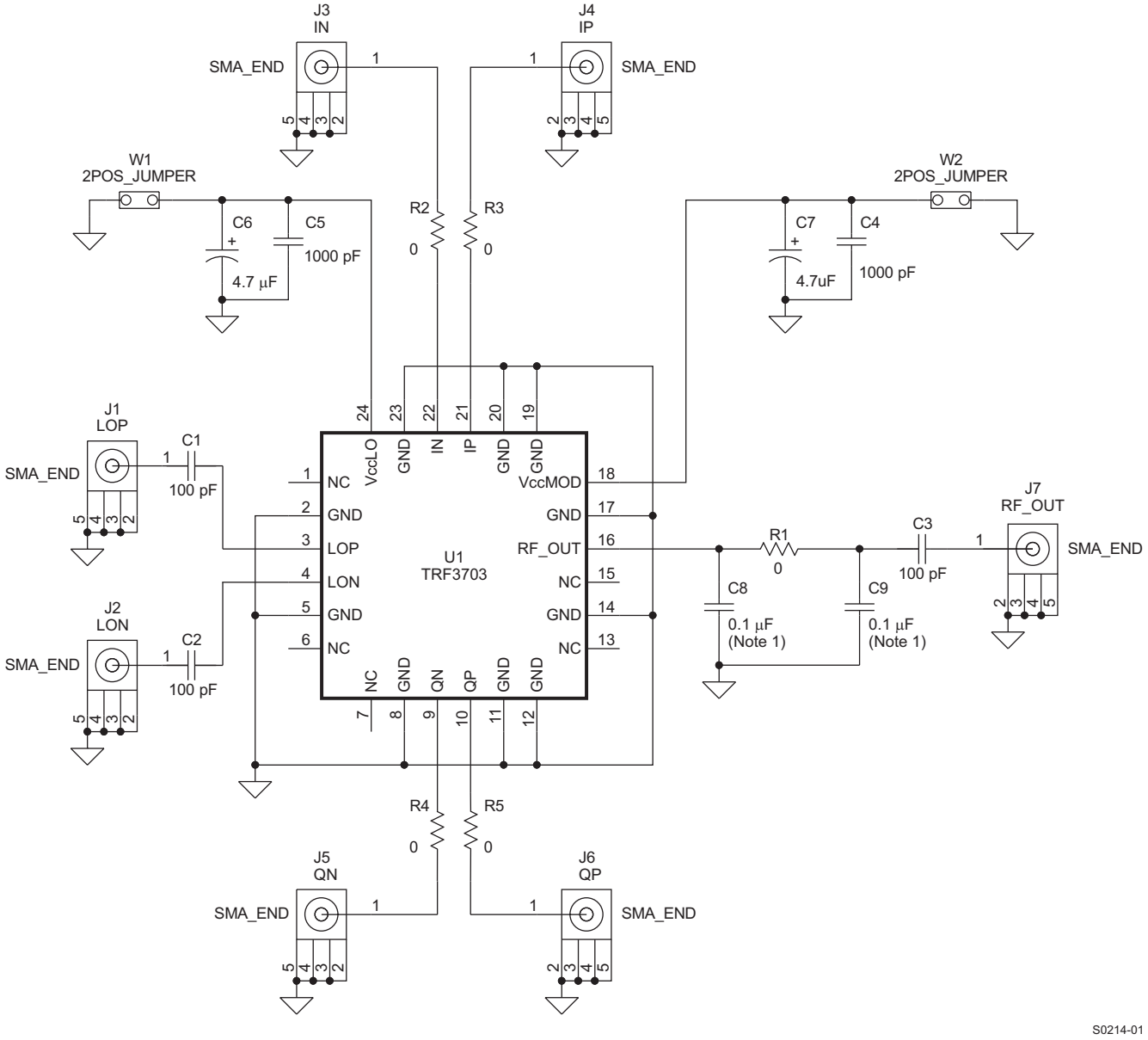

Figure 5. TRF3703 EVM Schematic

3 Conclusions/Results

The TRF3703xx quadrature modulator family has two separate power supplies. One is used to power the LO circuitry while the second is used to power the modulator circuitry. Turning off the modulator power supplies (pins 18 and 24) during the receive mode eliminates interference, intermodulation, carrier feedthrough, and saves power. The current reduction is roughly between 200 mA and 235 mA, corresponding to a power savings of approximately 1 W to 1.2 W.

4 References

1. *TRF3703 0.4-GHz to 4-GHz Quadrature Modulator* data sheet, (SLWS184) (for TRF370333 and TRF370315)
2. *TRF370317 0.4-GHz to 4-GHz Quadrature Modulator* data sheet (SLWS209)
3. *TRF3703 Quadrature Modulator Evaluation Module* user's guide, (SLWU042) (for TRF370333 and TRF370315)
4. *TRF3703-17 Quadrature Modulator Evaluation Module* user's guide (SLWU054)

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